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MEDICINE AND THE ALLIED SCIENCES

MEDICINE AND THE ALLIED SCIENCES

IN THREE VOLUMES

VOLUME I

SECTIONS I–V

BACTERIOLOGY, PATHOLOGY, PHYSIOLOGY
CHEMISTRY, ANATOMY

BY

SAMUEL FOMON, Ph.D., M.D.

MAJOR MEDICAL RESERVE CORPS, UNITED STATES ARMY

WITH TWO HUNDRED AND EIGHTY-TWO TEXT ILLUSTRATIONS,
FIFTY-FOUR OF WHICH ARE COLORED, AND THIRTEEN COLORED PLATES

PUBLISHED BY PERMISSION OF THE
SURGEON GENERAL OF THE ARMY

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1919

MP

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TO

MY WIFE

THIS BOOK IS DEDICATED IN GRATEFUL ACKNOWLEDGMENT OF HER SUSTAINING INTEREST IN THIS WORK, AND WITHOUT WHICH IT NEVER WOULD HAVE BEEN WRITTEN

70273

PREFACE

The rapid advance in the Standards of Medical Educati[on] [t]he inc[reas]ing stress laid on diagnostic methods, the continuous change[s] [i]n [m]edicine because of an increased knowledge of chemistry, biology [and] [p]athology have placed the busy practitioner, especially the one who gr[aduated] years ago, under a great strain in his attempts to keep pace with the advances of medicine.

Indeed, many find it impossible to keep in touch with the advances, because they lack a proper knowledge of fundamental subjects which were not found in the medical college curriculum of a few years ago.

This presentation of Medicine and the Allied Sciences is the outgrowth of more than a decade devoted exclusively to the instruction of Post and Undergraduate Students. During this time it has been my privilege personally to instruct thousands of students and practitioners.

The experience so gained has afforded me an unusual opportunity to study the defects in the methods of medical instruction generally prevailing in this country. These defects are readily acknowledged by teachers of medicine, who, nevertheless, have been unable to effect a remedy, because of the system which allows each department to work to a greater or a less extent independently of the others, and under which teachers have been selected more because of their reputations or abilities as research workers, than for their abilities to impart knowledge.

Likewise the rapid and unequal development of the several departments constituting the medical sciences has tended to a corresponding unevenness in medical instruction. Thus surgery, during the era of its greatest development, so dominated the attention of the profession that it, in a large measure, overshadowed the importance of internal medicine, and yet it was in this latter field that the great majority of graduates were to apply their professional knowledge.

There is lacking a practical discrimination between essentials and non-essentials, between facts and theories, and a balanced estimation of proportional values of each medical study. Above all—and the most obvious fact to those who have enjoyed the same intimate contact with medical students that I have—is the need for coördination, whereby it may be possible to focus on any individual branch all that every department of medical knowledge has to offer.

It is to this task that I have addressed myself and the result is the following volumes of Medicine and the Allied Sciences.

The methods and outlines here employed have been laboriously worked out in my classrooms before an attendance of more than 11,000 students. I make no claim for originality other than the manner of presentation. The facts ecorded have been taken from the writings of acknowledged authorities. Where it has been necessary to present theories, only those which have the weight of authority behind them have been given.

Medicine and the Allied Sciences is so different in character and methods from any medical work thus far published, that it is thought necessary to prepare a key which will enable the user successfully to comprehend the unusual arrangement of the subject matter.

Finally, I desire to acknowledge my indebtedness to the students who have attended my courses and thereby have afforded me the media, as it were, for the testing and development of the ideas found in this work.

SAMUEL FOMON.

INTRODUCTION

The world is full of facts. Facts are the cogs on the wheels of existence. Out of the countless number of facts we must concentrate upon those that are immediately concerned with our lives and work. How to choose what serves and to reject what merely cumbers is the problem.

To index, to arrange them, so that every fact, every item of l
carry along with it its full implication and of itself bring us wi
of the related facts concerning us, thus making possible a comprehen
a firm grasp and a full understanding, is the task.

Problem and task require a method—a method based on the exclusion of the unrelated and non-essential facts and the retention of those that are cru
key-facts—the spokesmen for all the rest.

This is true of life in general and is compellingly true of the medical sciences and the art of medicine in particular.

The medical sciences with their hardy roots deeply planted in the potentialities of primitive stuff, held in place by an endlessly cumulative environment which is heredity, present a background of eternal cosmic commerce in fact.

The art of medicine, constituting the body of the tree, with its branches of effort and fruit of accomplishment, comes into contact, is subjected to, is swayed and influenced, helped or hindered, by the other pole of existence—environment—whose interaction with man may be termed cosmic metabolism.

Environment, the mother of heredity, the sphere of privilege for man's conscious reaction to nature, with its many phases of climate, food, economic groundwork, social conditions, prevailing ethics, racial and national traditions—each and all offer their rich sheaves of fact contributing to or hindering man's physical well-being, which is the particular care and province of the art of medicine.

Dr. Fomon's work was inspired by the recognition of the fact that "art is long and life is short." Hence the effort to present the sciences pertaining to the theory and practice of medicine, within the covers of one compassable book. It may readily be seen that this would be an almost impossible task, unless some method were chosen that would allow of the presentation of the several medical branches in a manner that would give the square-root facts of medicine in outline form, yet, so arranged that each statement of facts bears along with it the full implication of related facts and throws the cementing light of understanding upon what precedes and what follows it. It is

only by such a happy combination of brevity of statement, so linked that the significance of each is self-evident, that, to use a figure, the maximum of momentum with the minimum of weight was attained.

To do that required many years of work and a huge amount of intense application, an ability to glean, gather and sift the facts pertaining to the medical sciences, to prune them of superfluity; to marshal and cogently bind them together so logically that they will present an organic whole, of definite shape and form, bereft of all adipose and not suffering from halting and vitiating plethora.

This task Dr. Fomon accomplished in Medicine and the Allied Sciences, a work which will lighten the task of student and practitioner in his quest for basic knowledge of the medical sciences without which the understanding of the deeper medical problems is not possible.

It is evident that only one who has devoted himself exclusively to the teaching of the medical sciences could gather all the facts and elaborate, by repeated efforts and trial, such a method, produce such a work. Only the constant grappling with many textbooks, the weighing and balancing of the statements of many authorities, the need of presenting the entire realm of medicine in brief and mnemonic form, could produce such a desirable result.

The book is a well-planned atlas of the highways of the medical sciences through which those interested may reach the deeper and more abstruse labyrinths. It is a deserving culmination of a worthy effort.

HYMAN COHEN, M.D.

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MEDICINE AND THE ALLIED SCIENCES

SECTION 1

BACTERIOLOGY

A—GENERAL OUTLINE—Employed in describing bacteria

I—Name and Synonym
II—Morphology
1—Size
2—Shape
3—Grouping
4—Capsule
5—Spores
6—Motility
7—Flagella
III—Stains
1—Ordinary
2—Gram's
3—Special
IV—Culture
1—Physical conditions
A—Air
B—Temperature
C—Reproduction
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V—Distribution
1—Within the body
2—Without the body
VI—Resistance
1—Heat and cold

2—Injury
3—Drugs
VII—Special reaction
1—Widal
VIII—Pathogenicity

B—GENERAL OUTLINE—Amplification

The following outline is an average description of all the bacteria. The exceptions to each organism will be found in the text.
Given an organism to describe, the student is expected to go through the entire outline giving features common to all bacteria and noting the exceptions.

I—Name and Synonym
II—Morphology
1—Size
All cocci ½ to 1 micron in diameter.
All bacilli and spirilla 1–3 microns long, unless stated otherwise in text.
2—Shape
From name; coccus—round, bacillus—rod, spirillum—spiral.
3—Grouping
Singly or in pairs, unless name gives clew, such as staphylococcus, grape like bunches; streptococcus, in form of chains; diplococcus, in pairs.
4—Capsule
None; exceptions given in text.
5—Spores
None; exceptions given in text.
6—Motility
None; exceptions given in text.
7—Flagella
None; exceptions given in text.
III—Staining
1—All stain with the ordinary stain; exceptions given in text
2—Gram's stain
A—All cocci stain with the Gram stain except:
a—Gonococcus
b—Meningococcus
c—Micrococcus melitensis
3—Special stain
A—No organism has a special stain—unless stated otherwise

GENERAL OUTLINE

IV—Cultural characteristics

1—Physical conditions

A—Air

All are aërobic and facultative anaër
given in text.

B—Temperature

All grow best at the body temperatu
C.); exceptions given in text.

C—Reproduction

By fission unless organism has spores.

2—Media

A—Bouillon

All bacteria cloud bouillon in 12 hou
hours with a sediment in the bottom of

B—Gelatin

All grow as small dew-drop colonies elevated i
flattened at the periphery, crenated edges.

C—Agar

No bacterium liquefies agar.

D—Potato

Thin, veil-like growth, except typhoid, which pr
a thick invisible growth.

E—Nothing special on:

a—Milk

b—Blood serum

c—Special media

V—Distribution

1—In the body

Liver, kidney, spleen, mesenteric glands, mouth and blood unless stated otherwise in the text.

2—Outside of the body

A—Soiled instruments and dressings

B—Air of medical and surgical wards

C—Exceptions noted in text.

VI—Resistance

1—Heat (240 degrees F.) kills bacteria in ½ hour

2—Cold inhibits growth of all bacteria

3—Injury, drying, destroys all bacteria

4—Drugs: 5% phenol and 1–1000 bichloride of mercury destroys in one hour.

VII—Special reaction

Such as Widal (given in text-books).

VIII—Pathogenicity

Injection of bacteria into a guinea pig causes the death of the guinea pig in 48 hours from septicemia, unless stated otherwise in the text

C—METHOD OF STUDY

In text, under the pneumococcus, the following is given:

Micrococcus pneumoniae (Fraenkel)

I—Morphology—united in pairs; surrounded by capsule; non-motile, no flagella

II—Cultural characteristics—aërobic, grows at body temperature, clouds bouillon, on agar grows as small dewdrop colonies, coagulates milk

The student is expected to describe the organism, employing the entire outline, and inserting the exceptions as follows:

Name

Pneumococcus

Synonym

Diplococcus of Fraenkel

Morphology

1—Size

1–3 microns in diameter

2—Shape

Round

3—Grouping

In pairs

4—Capsule

Encapsulated

5—Spores

None

6—Flagella

None

7—Motility

None

Staining

1—Ordinary

2—Gram positive

3—Special stain, none

Cultural characteristics

1—Physical conditions

A—Air

Aërobic and facultative anaërobic

B—Temperature
Grows best at body temperature
C—Reproduction
By fission
2—Media
Bouillon
Clouds in 12 hours, clears in 24 hours with a sediment at bottom of tube.
Agar
Does not liquefy.
Gelatin
Dewdrop colonies: elevated at center, flattened at periphery.
Potato
Thin veil.
Milk
Coagulates.

Distribution
1—In body
Everywhere; especially in respiratory passages, liver, kidney, spleen.
2—Outside of body
Soiled instruments and dressings.

Resistance
Heat: 240 degrees F. kills; cold inhibits growth; 5% phenol and 1:1,000 bichlorid of mercury destroys

Special reaction
1—None

Pathogenicity
Injected into guinea pig, kills in 48 hours from septicemia

D—FUNDAMENTAL PRINCIPLES

I—Definitions
1—Bacteria are unicellular organisms, divide by fission, and belong to the vegetable kingdom
2—Chemical composition of bacteria
Water.....80–88%
Balance—
Phosphoric acid, sulphur, potassium, chlorin, calcium, magnesium, iron, silica, hemicellulose, nuclein, hypoxanthin, guanin, adenin.
3—Toxins are poisonous products of pathogenic bacteria developed in the LIVING BODY.

4—Ptomains are substances resembling alkaloids formed in DEAD MATTER.

5—Leukomains, poisonous products developed in the living body, due to perverted metabolism

6—Amboceptors are antibodies having a double combining power, one linking on to the cell to be destroyed and the other to the alexin or complement

7—Bacterio-proteins are proteins contained in bacteria

8—Anaphylaxis, a condition of super-sensitization induced by the injection of a serum. It is the opposite of prophylaxis and in place of rendering the person injected immune, the serum makes him particularly susceptible. It has been manifested in some instances by alarming symptoms, such as heart failure, collapse, convulsions and coma

9—Lysins are bacterial products which are capable of destroying alexins and so promote the growth of bacteria

10—Germicides: substances which destroy germ life

11—Antiseptics retard the growth of germs

12—Asepsis, absence of germ life

13—Sterilization: process by means of which a substance is rendered aseptic

A—Direct, produced by

a—Heat, moist or dry

b—Steam, under pressure

c—Chemicals

d—Electricity

B—Indirect, intermittent or fractional

a—Arnold's sterilizer for 15 minutes

b—Let stand for 24 hours to allow the spores to develop into bacteria; put into Arnold's sterilizer again for 15 minutes

c—Repeat again in 24 hours to make sure

14—Tuberculin: a 50% glycerin extract of the tubercle bacillus used as a diagnostic and therapeutic agent. .001 to .005 gm. injected produces constitutional symptoms of tuberculosis

Various methods employed in diagnosis

A—Calmette

One drop of a 1% solution instilled into the eye. Inflammatory reaction in 6–10 hours indicates a positive reaction

B—Von Pirquet

Cutaneous test: tuberculin rubbed into skin. Produces inflammatory reaction

c—Moro

Inunction into skin. Produces signs of inflammation

15—The opsonic index is the average germs per leukocyte in the diseased individual as compared with the average number of germs ingested by the healthy leukocyte

16—Opsonins: substances in blood serum which act on bacterial cells in such a way that the leukocyte is enabled to take them up

17—The Wassermann Reaction

A—Definition

A complement fixation test in Syphilis. The principle involved is that hemolysis does not occur in the presence of a hemolytic amboceptor when emulsions of bacteria are mixed with an inactivated serum, with the addition of a complement. The reason is that the complement binds itself with the bacteria and thus prevents the union of complement with the red cells through the medium of the amboceptor

B—Consists of

a—Syphilitic serum with an alcoholic extract of heart muscles and sheep's corpuscles, No HEMOLYSIS

b—Control

1—Normal blood serum

***2*—Heart extract**

***3*—Sheep's corpuscles, HEMOLYSIS OCCURS**

c—Technique

a—Technique of Wassermann Reaction. To obtain

***1*—Positive Reaction**

A—Antibody
(Patient's inactivated serum)

B—Antigen
(Extract of syphilitic fetus)

C—Complement
(Normal serum from guinea pig)
Incubate for 45 minutes, complement is fixed.

D—Add hemolytic amboceptor (serum from rabbit immunized with sheep's erythrocytes)

E—Suspension of specific red blood cells (sheep's) is added

F—Result, no hemolysis

- [illegible] The antibody will be destroyed the complement and prevents the hemolytic amboceptor from combining with the complement. This prevents hemolysis. Use is presence of immune anti-human serum

- Steps in reaction
  - Antigen
  - Human serum
  - Complement
  - Sheep's red corpuscles
  - Hemolytic amboceptor
  - Control tubes
  - Test tube: The antibody in normal serum + complement + red hemolytic amboceptor fixed + red produced hemolysis

- Time of reaction. When positive, shows syphilis
  - Present
    - In primary, secondary, tertiary, latent and hereditary syphilis 80–90%
    - General paresis 80%
    - Tabes dorsalis 80%
    - Present in other diseases such as scarlet fever, leprosy, trypanosomiasis but these diseases can be easily differentiated
  - Time reaction appears
    - Fourth week of disease
    - May disappear on treatment

- Wagner's modification of the Wassermann
  - A Antigen prepared by extracting the lipoid substance from liver and heart of dog and cow
  - B Human corpuscles used instead of sheep's
  - C Hemolytic amboceptor obtained by immunizing rabbit with washed human corpuscles
  - D Preservation of the specific antigen and the hemolytic amboceptor by soaking strips of filter paper with each .

E—Technique

A strip of antigen filter paper brought in contact with human blood to be tested and fresh guinea pig serum added, the whole suspended in an isotonic salt solution. This is kept at incubator temperature, hemolytic series added by a strip of hemolytic amboceptor paper, and a definite quantity of washed human blood corpuscles.

18—Classification of bacteria

A—Morphologic

a—Cocci (Spherical organism)

1—Diplococci; in pairs

2—Streptococci, in chains

3—Staphylococci, in bunches like grapes

4—Sarcinae, in groups of eight

b—Bacilli (Rod shaped)

c—Spirilla (Spiral shaped)

B—Physiologic

a—Pathogenic; produces disease

b—Non-pathogenic, no disease producers

c—Parasitic; live on living body

d—Saprophytic; live on dead matter

C—As to reaction to air

a—Aërobic, live in air

b—Anaërobic, can live only without air

c—Obligate, are obliged to live in any single condition

d—Facultative; can live with or without air

19—Vital products or functions of bacteria

A—Fermentation

B—Putrefaction

C—Chromogenic (Pigments)

D—Photogenic (light producers)

E—Produce ptomains and toxins

F—Acids and alkalis

G—Produce gases

H—Aromatics

20—Koch postulates or laws

To prove the pathogenicity of a certain organism

a—The same organism must always be present in the same disease

- The organism must be isolated and grown in artificial media
- On inoculation of mixture in animal must produce the same disease
- The same organism is to be isolated from the lastly inoculated animal

21- *Reproduction of bacteria*

- *Fission*
  - The organism divides into two, the most common method
- *Spores*
  - Develop when conditions for growth become unfavorable
    1. *Endospore*: there develops within the body of the bacterium a highly refractile body
    2. *Arthrospore*: protrusion from cell becomes spore outside of the cell

22 *Alexins*

Substances in the blood having bactericidal properties

23 *Antitoxins*

Substances in the blood capable of protecting against toxins

24 *Chemotaxis*- chemical attraction

- *Positive*, attracts leukocytes
- *Negative*, repels leukocytes

25 *Phagocyte*

Polynuclear leukocyte, capable of devouring living or dead bacteria

26 *Culture*

Nutritive media for the growth of large masses of bacteria. *Their object*, to isolate different species of bacteria. Three *tubes are inoculated*, first from culture, second tube from *the first*, third tube from the second. Place on Petri dishes. *The gelatine* now solidifies and imprisons the separated *cells*. *Each* of these now multiplies and reproduces its *kind*; in the course of a day or two a small growth, the size *of a small* pinhead, appears. This is called a colony, and since it is derived from a single cell, it constitutes a pure culture. Such is the principle of the dilution method for obtaining pure cultures. The isolation accomplished, all that is necessary is to transplant the colony to sterile culture media, so as to continue the growth

27 *Flagella*

Are delicate hair like projections from bacteria, and serve as organs of locomotion

28—Conditions necessary for the growth of bacteria
- A—Proper temperature; near that of the body
- B—Oxygen is generally needed, those that cannot live without it being called aërobic, and those that can grow without it, anaërobic
- C—Nutriment of a proper kind, containing both organic and inorganic material
- D—A slight degree of moisture
- E—A medium of slightly alkaline reaction
- F—Rest, individual bacteria may require modifications of the above essentials

29—Method of inoculation of culture into animals
- A—Rub culture into skin
- B—Subcutaneous
- C—Intravenous
- D—Into the lymphatics
- E—Intra-peritoneal
- F—Anterior chamber of the eye

30—Immunity is the insusceptibility of certain individuals to disease despite the entrance of pathogenic bacteria
- A—Natural immunity—inherited
- B—Acquired
  - a—Active, attack of the disease or vaccination
  - b—Passive, injection of antitoxin

31—Method of producing immunity
- **A—Inoculation with small quantities of bacteria**
- **B—Vaccination**
- **C—Intoxication, introduction of small quantities of toxin**
- **D—Antitoxin**
- **E—Inoculation with emulsion of tissue**
- **F—Inoculation of inert particles with bacteria**

32—Theories of immunity
- **A—Abstraction theory; pabulum necessary for growth is exhausted**
- **B—Retention theory; micro-organisms produce a substance that stops their growth**
- **C—Phagocytosis; leukocytes destroy bacteria**
- **D—Ehrlich's Side Chain Theory; body composed of cell groups having lateral chains called receptors. A toxin has a chain, called haptophore, which unites with the receptor to produce disease. Infection stimulates cell to form receptors, which are liberated free in the blood stream and now are called antibodies. These unite**

with the haptophores of toxins, which make them harmless

FIG. 1.—Diagram to illustrate Ehrlich's side chain theory

33—Natural protection against bacteria
- A—Blood and gastric juice
- B—Acidity of the urine and of the gastric juice
- C—The alkalinity of most of the other secretions
- D—The phagocytic action of the blood
- E—The blood and lymph are bactericidal in their action
- F—The agglutinating action of the blood
- G—The living body is also capable of producing antitoxins

34—Staining
- A—Ordinary stain
  - a—Spread material on slide
  - b—Dry in air
  - c—Fix in flame
  - d—Methylene blue 1–2 minutes
  - e—Wash in water
  - f—Dry in air or blot between filter paper
  - g—Mount in Canada balsam
  - h—Examine with oil immersion lens
- B—Gram's stain a, b, c, f, g, h, as above. In place of d
  - a—Anilin Gentian violet ½ minute
  - b—Lugol's solution until black
  - c—Alcohol 95%
  - d—Counter stain, Bismarck brown

    All organisms that are positive to Gram's are stained violet; organisms negative to Gram's are stained brown.
- C—Special stains (in place of d)
  - a—Ziehl-Neelson's Stain for the tubercle bacillus
    - *1*—Carbolfuchsin; steam for 5 minutes
    - *2*—Decolorize in 10% mineral acid
    - *3*—Counter stain with methylene blue

4—Everything in field is blue except the tubercle bacillus, which is red

b—Loeffler's alkaline methylene blue for the Klebs-Loeffler bacillus

c—Giemsa's Stain for the spirochaeta pallida

d—Neisser's Stain for differential diagnosis of diphtheria

Number 1

A—Methylene blue	1 gm.
B—96% Alcohol	20 cc.
C—When dissolved add Aqua destillata	950 cc.
D—Glacial acetic acid	50 cc.

Number 2

A—Bismarck brown	1 part
B—Boiling distilled water	520 parts

Place the cover-glass smear in solution number 1 for 2 to 3 seconds, and then *wash* in solution number 2, for 3 to 5 seconds. The stained bacilli will appear brown or will show at one or both ends a dark blue round body. With typical virulent diphtheria bacilli, from a 12 to 18 hours' growth, nearly all will exhibit the blue polar staining, while with the non-virulent or pseudo-diphtheria bacilli, few, if any, will show such dark bodies.

SPECIAL BACTERIOLOGY

The special features are given here. The student is expected to run through the entire outline (given on *page one*) with each germ, noting the exceptions.

A—PATHOGENIC BACTERIA

I—Pyogenic cocci (Pus producers)

1—Staphylococcus pyogenes

A—Aureus

B—Albus

C—Citreus

2—Streptococcus pyogenes
3—Gonococcus
4—Pneumococcus
5—Meningococcus

II—Individual features of pyogenic cocci

1—Staphylococcus pyogenes aureus

A—Morphology; ½ to 1 microns in diameter
B—Cultural characteristics; liquefies gelatin. Stab liquefies in form of nail; on agar spherical yellow brown colonies
C—Staining: with all anilin dyes; Positive to Gram's
D—With above exception fits outline

FIG. 2.—Staphylococcus Pyogenes Aureus

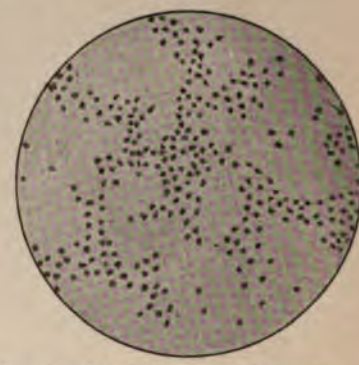


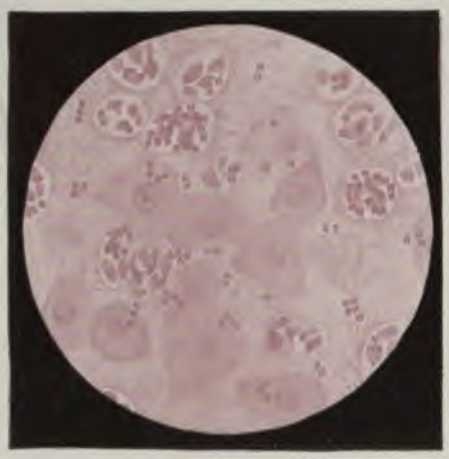
FIG. 3.—Staphylococcus Pyogenes Albus

2—Staphylococcus pyogenes albus, same as above. Colonies are colorless
3—Staphylococcus pyogenes citreus, same as above. Colonies yellow color
4—Streptococcus pyogenes

FIG. 4.—Streptococcus Pyogenes

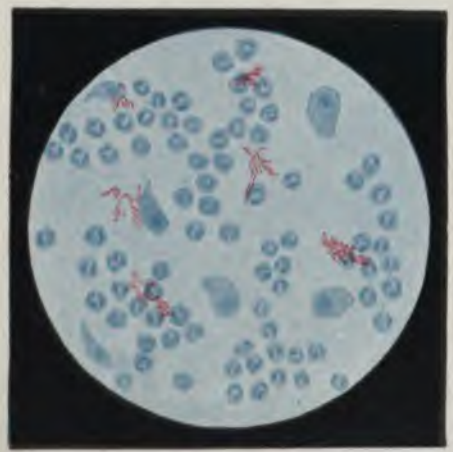
FIG. 5.—Streptococcus Erysipelatis

PLATE I



1

2



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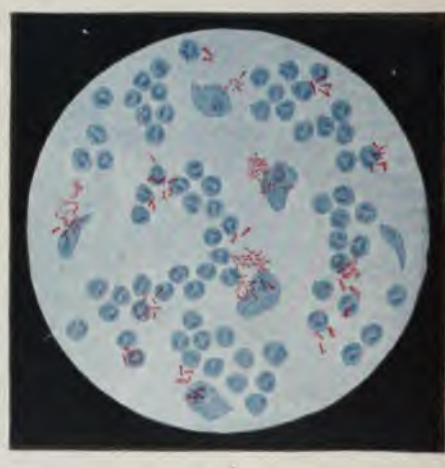


4

MICROPHOTOGRAPHS OF GONOCOCCI AND TUBERCLE BACILLI.

FIG. 1.—Gonorrheal pus. First stain: gentian-violet solution.

FIG. 2.—Gonorrheal pus. Bismarck-brown. Cells and gonococci take the brown stain, while the pseudogonococci remain black.

FIG. 3.—Tubercle bacilli in urine.

FIG. 4.—Smegma bacilli in urine.

A—Morphology: micrococcus, 1 to 4 microns in diameter; grouping in chains

B—Does not liquefy gelatin

5—Gonococcus (Neisser)

A—Morphology: occurs in pairs, flattened surface opposed, within polynuclear cells, like coffee bean

B—Cultural: aërobic, will grow only on media containing blood

C—Staining: all ordinary stains; gram negative

6—Micrococcus pneumoniae (Fraenkel)

A—Morphology: lancet shaped, in pairs, surrounded by capsule

B—Cultural: aërobic, non-motile, no flagella, grows at body temperature, clouds bouillon on agar, grows as small dewdrop colonies, coagulates milk.

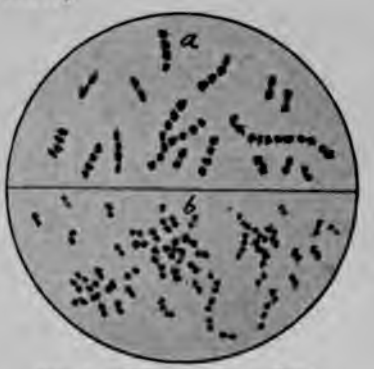


FIG. 6.—Pneumococcus Pure Culture
a Long Chains
b Short Chains

7—Micrococcus melitensis (Bruce; Bacillus melitensis (Babes)

A—Morphology: non-motile, non-flagellate, non-sporogenous

B—Staining: ordinary methods, but not by Gram's method

C—Cultural: characterized by slow growth; non-chromogenic, non-liquefying

D—Pathogenic action upon monkeys

8—Diplococcus intracellularis meningitidis (Weichselbaum)

A—Morphology: occurs in bunches of two, small oval cocci; no flagella, no motility

B—Staining: with all stains. Gram negative

C—Cultural: aërobic, grows on all media as transparent shining colonies, does not liquefy gelatin

D—To obtain lumbar puncture

a—Patient on left side

b—Sterilize hand and back

c—Aspirating needle between second and third lumbar vertebrae

d—Remove 10 cc., stain and examine

III—Individual features of BACILLI

1—Bacillus tuberculosis (Koch)

A—Morphology: slender rod 1–3 microns long, single or

pairs, occasionally curved, found in tubercular tissue; no capsules; no spores; no motility

B—Cultural: aërobic, grows with difficulty on media, best in 8% glycerin agar as dried up, scaly looking mass killed by exposure to sunshine or by 70 degrees C.

C—Staining: with Ziehl's Carbolfuchsin

2—Bacillus of leprosy (Hansen)

A—Morphology: small, straight rod; pointed ends; 5–6 microns long; resembles bacillus tuberculosis

FIG. 7.—Bacillus Tuberculosis in Sputum

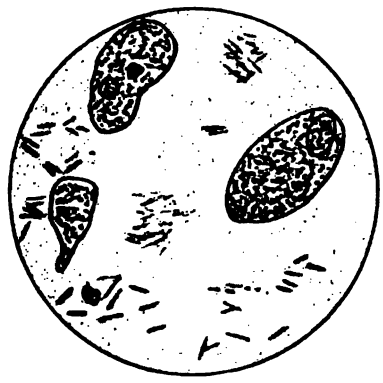


FIG. 8.—Bacillus of Leprosy

B—Cultural: grows in glycerin agar as twisted band; yellow gray color

C—Staining: with Gram

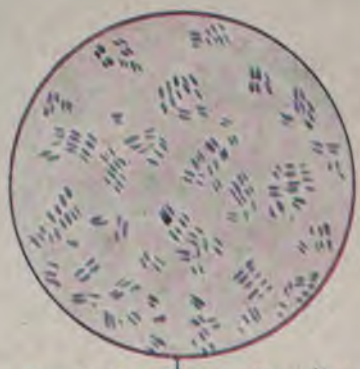
D—Differentiation

BACILLUS TUBERCULOSIS	BACILLUS LEPRAE
a—Does not stain so readily	a—Stains with watery solution of fuchsin, retains stain when treated subsequently with acid alcohol
b—Not so numerous, harder to find	b—Found in enormous numbers, beaded; lie in masses like a bundle of cigars
c—Cultivated outside of body	c—Cultivated with great difficulty
d—Injected into pig may produce tubercles	d—Does not produce tubercles

3—Bacillus mallei (Causes glanders)

A—Morphology: long rod, rounded pointed ends, non-motile, no flagella, non-sporogenous

PLATE II

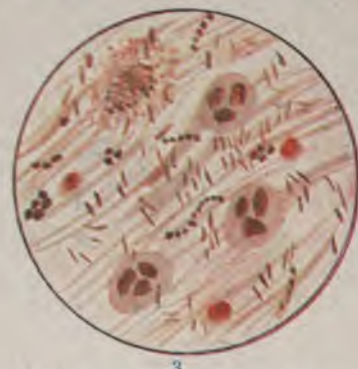


1

Pseudo-Diphtheria Bacillus

2

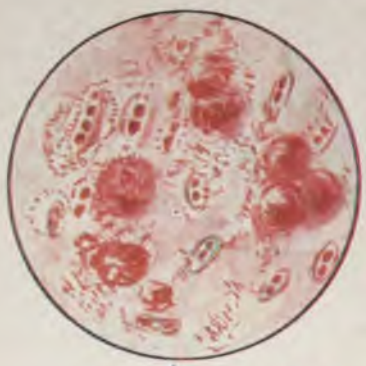
Bacillus Aerogenes Capsulatus



3

Diphtheric Exudate

Diphtheria Bacilli, Streptococci & Staphylococci



4

Pneumococcus Sputum.

5

Diphtheria Bacillus. Typical Form

B—Cultural: grows on all media as a mois
does not liquefy gelatin; produces acid, clouds bo
C—Diagnosis: tumefaction of testicle on inoculatic
guinea pig

4—Bacillus Anthracis or bacillus of anthrax (Koch)

A—Morphology: large rod 10–15 microns; end of rod square; single or in pairs; contains spores; no flagel no motility

B—Cultural: anaërobic, grows on all media in tv ed threads, resembling cotton; head of Medu e growth; does not cloud bouillon or agar

C—Staining: ordinary and Gram's

FIG. 9.—Bacillus Anthracis (Agar Culture)

FIG. 9a.—Bacillus Anthracis (In Blood)

5—Bacillus Diphtheria (Klebs-Loeffler's)

A—Morphology: short rod 2–5 microns in length, single or in pairs, or irregular groups; straight or curved ends; body may bulge in center

B—Stains: with all stains and with Gram's stain; best with Loeffler's alkaline methylene blue

C—Cultural: aërobic; grows on all media as grayish white pin head colonies, becomes larger, elevated and yellow center more opaque than periphery. Bouillon, small clots on sides and bottom of tube, some float on top as pellicle. Bouillon becomes clear; gas is formed. Gelatin: small irregular colonies, notched elevated center, flat periphery. Milk, no change. Potato, thin white veil

D—To obtain a culture

A sterile swab is rubbed over any visible membrane on the tonsils or throat and is then immediately passed over the surface of the serum in a culture tube. The tube of culture thus inoculated, is placed in an incu-

bator at 37° C. for about twelve hours, when it is ready for examination. A sterile platinum wire is inserted into the culture tube and a number of colonies of a whitish color are removed by it and placed on a clean cover slip and smeared over its surface. The smear is allowed to dry, is passed two or three times through a flame to fix the bacteria, and is then covered for about five or six minutes with a Loeffler's methylene-blue solution. The cover slip is then rinsed in clean water, dried and mounted.

The bacilli of diphtheria appear as short, thick rods with rounded ends. Irregular forms are characteristic of this bacillus and the staining will appear pronounced in some parts of the bacilli and deficient in other parts

E—Antitoxin: Production

a—Horse is immunized with dose of diphtheria toxin. First injection 1 cc.; wait eight days; repeat every few days until 300 cc. are given

b—Blood is removed, allowed to clot, the serum is removed and antiseptic is added. Standardization: .01 gram antitoxin should neutralize 1 gram of toxin. ANTITOXIN UNIT IS THE AMOUNT OF ANTITOXIN REQUIRED TO PROTECT A 300 GRAM GUINEA PIG AGAINST 100 TIMES THE FATAL DOSE

Dose

Pharyngeal diphtheria; 3,000 units
Laryngeal diphtheria; 5,000 units
Immunizing dose; 500–1,000 units

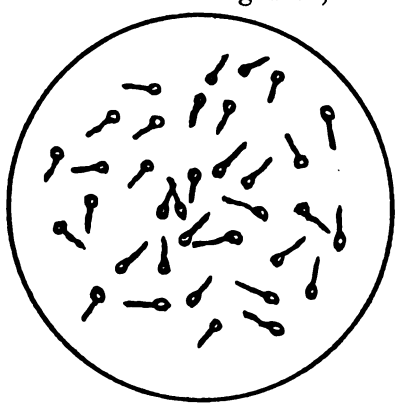


FIG. 10.—Tetanus Bacillus

6—Bacillus of Tetanus, or Bacillus Tetani (Flugge)

A—Morphology

a—Vegetative form: short rod, round ends; occurs in long filaments

b—Spore bearing form: looks like a pin

B—Cultural characteristics: motile, flagellated; anaërobic; grows on all media; liquefies gelatin and grows like a fir tree. Produces gas; bad odor; no coagulation of milk

C—Staining: ordinary and Gram

7—Bacillus Aerogenes Capsulatus (Welch)

A—Morphology: large, non-motile, non-flagellated sporogenous

B—Staining: ordinary and Gram

C—Cultural: non-chromogenic, purely anaërobic, aërogenic

8—Bacillus of Malignant edema (Koch)

A—Morphology: rod, 3–5 microns; forms spores in center, motility and flagella

B—Cultural characteristics: anaërobic, grows in all media as small colonies on bottom of tube; forms gas; liquefies gelatin

C—Staining: ordinary stains; Gram negative

FIG. 11.—Bacillus Edematous Maligni

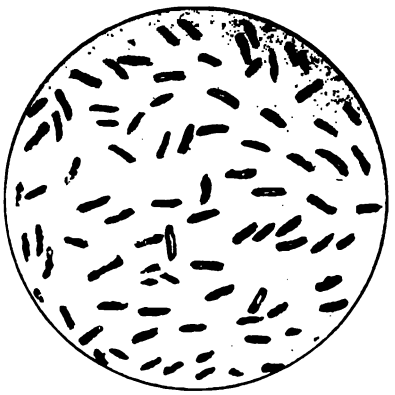


Fig. 12.—Bacillus Typhosus Agar Culture

9—Bacillus Typhosus

A—Morphology: short oval rods; flagellated, motile, no spores

B—Staining: stains with all stains; Gram negative

C—Cultural: aërobic, grows in all media, as small irregular colonies, shining gray white color. No coagulation of milk; no acid; no indol

D—Widal Reaction: blood serum of typhoid patient agglutinates typhoid bacilli

E—Technique of Widal

Three drops of blood are taken from the well washed aseptic finger tip or lobe of the ear, and each lies by itself on a sterile slide, passed through a flame and cooled just before use; this slide may be wrapped in cotton and transported for examination at the laboratory; here one drop is mixed with a large drop of sterile water, to redissolve it. A drop from the summit of this is then mixed with six drops of fresh broth

FIG. 12a.—Potato Culture

FIG. 12b.—Bouillon Culture

culture of the bacillus (not over twenty-four hours old) on a sterile slide. From this a small drop of mingled culture and blood is placed in the middle of a sterile cover-glass, and this is inverted over a sterile hollow-ground slide and examined. A positive reaction is obtained when all the bacilli present gather in one or two masses or clumps and cease their rapid movements within twenty minutes

10—Bacillus coli communis

A—Morphology: resembles typhoid with following

B—Differentiation:

BACILLUS TYPHOSIS	BACILLUS COLI COMMUNIS
MICROSCOPICALLY	
a—More flagella (10–20)	a—Less flagella (8–10)
b—More motility	b—Less motility
c—Widal present	c—Widal absent
d—More slender	d—Thicker
CULTURALLY	
a—Potato: luxuriant invisible growth	a—Potato: slimy yellowish growth

b—No curdling of milk	b—Curdles milk
c—No indol production	c—Produces indol
d—No gas production	d—Gas production
e—Gelatin thin, slow growth	e—Gelatin, broad, dense, more rapid growth
f—No acid production	f—Acid production

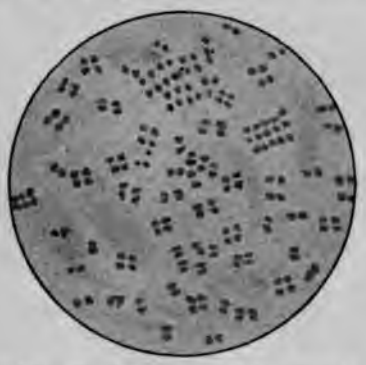


FIG. 13.—Bacillus Coli Communis

11—Cholera Bacillus (Comma Bacillus) (Koch)

A—Morphology: two may unite to form thick curved rod called Vibrio; S shaped spirillum; motility; flagella

B—Cultural: aërobic, stab liquefies in gelatin in form of nail; coagulates milk; produces acid, clouds bouillon

FIG. 14.—Spirillum of Asiatic Cholera

12—Bacillus Bordet-Gengou (Whooping Cough)

A—Morphology: oval rod 1.5 microns in length, pleomorphous; no spores, no motility, no flagella

B—Staining: stains with difficulty with ordinary stains; Gram negative

13—Bacillus Pyocyaneus (Gessard)
- A—Morphology: slender, motile, flagellated, non-sporogenous
- B—Cultural: chromogenic, aërobic liquefying
- C—Staining: ordinary methods, but not by Gram's method
- D—Feebly pathogenic

14—Bacillus Influenza (Pfeiffer)
- A—Morphology: short thick rod, singly or in pairs, no flagella or spores
- B—Cultural: aërobic; grows only in media containing blood. Transparent watery colonies resembling dew-drops
- C—Staining: all stains, Gram negative

15—Bacillus Ducrey
- A—Morphology: Ovoid, streptobacillus, with rounded ends, non-motile, non-flagellate, non-sporogenous
- B—Staining: ordinary method, but not by Gram's method
- C—Produces chancroid in man

16—Bacillus Pestis (Bubonic plague) (Yersin, Kitasato)
- A—Morphology: short, oval, pleomorphous, thick rod, no flagella
- B—Cultural: small sharply defined round masses, does not liquefy gelatin; clouds bouillon; no fermentation; no indol; no gas
- C—Staining: all stains, Gram negative

17—Bacillus Dysenteriae (Shiga)
- A—Morphology: 1–3 microns long
- B—Staining: Gram negative
- C—Cultural: Does not produce gas, acidifies then alkalizes milk, but causes no coagulation
- D—Distribution: Found in dejecta of dysenteric patients

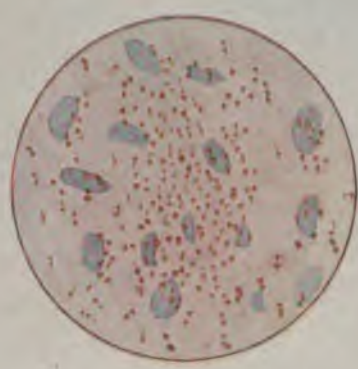
18—Koch-Weeks Bacillus
- A—Morphology: Slender, non-motile, non-flagellate, non-sporogenous
- B—Staining: Gram negative
- C—Cultural: Non-liquefying, non-chromogenic, aërobic and anaërobic
- D—Pathogenic for acute contagious conjunctivitis

IV—Individual features of SPIRILLA

1—Treponema Pallidum, the cause of syphilis. Slender spiral 4–20 microns in length with very close and regular turns. The curves vary from three or four to twelve or twenty. At each pole is a flagellum. It can move forward and backward and rotate on its axis. Division is transverse or longi-

PLATE III

1



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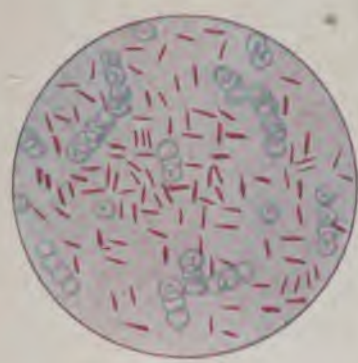


4

Fig. 1.—Spirillum Obermeier.
Fig. 2.—Bacillus Pestis.
Fig. 3.—Bacillus of Influenza.
Fig. 4.—Bacillus Dysenteriae.

PLATE IV

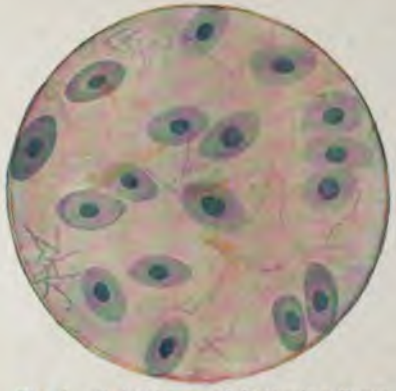


Fig. 1.—Spirochaete of Relapsing Fever, in the Blood. (After W. Kolle u. H. Hetsch, "Die experimentelle Bakteriologie, etc.," published by Urban & Schwarzenberg, Berlin.)

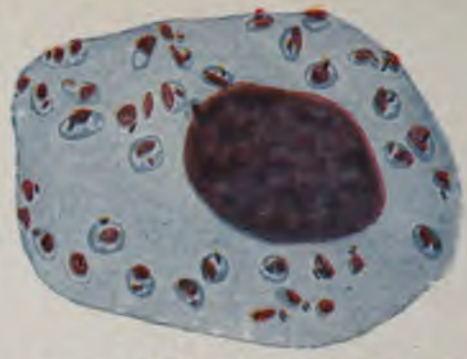


Fig. 2.—Kala-azar. Heavily-infected Macrophage from a Splenic Film. Leishman Stain. X 2,000. (After G. Buchanan, in "4th Report of the Burroughs Welcome Lab.," published by Baillière, Tindall & Cox, London.)

Fig. 3.—Trypanosoma gambiense. (After Chatard & Guthrie, 1914, Case Observed in Baltimore.)

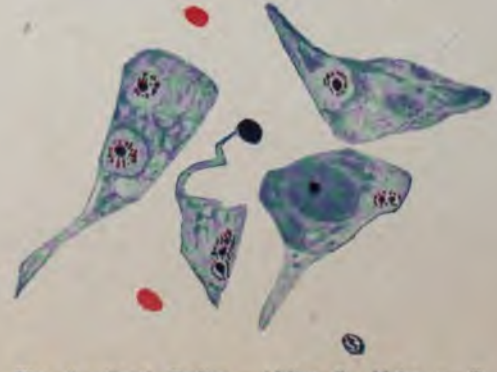


Fig. 4.—Negri Bodies. (After L. Mohr u. R. Staehelin, "Handb. d. inner. Med.," published by J. Springer, Berlin.)

tudinal. It has not yet been cultivated on [illegible] media.

2—Spirillum Obermeieri. Causes relapsing fever. During fever, occurs in blood as long twisted filaments, after crisis, seen in leukocytes as degenerated curved rods

3—Spirillum of Finkler-Prior; motile, liquefies gelatin, and non-pathogenic. Found in cholera dejecta

B—PATHOGENIC ORGANISMS OTHER THAN BACTERIA

I—Fungi or yeasts and molds

1—Blastomyces is a yeast fungus. It may invade skin, kidneys, and lungs, and is pathogenic for man

2—Actinomyces or Ray-Fungus: pathogenic for man and animals; found in grain, particularly in barley. The place of election is the lower jaw. Gram positive. In liquid media appears as granular masses yellow in color. Under microscope, number of threads showing bulbous club-like termination

II—Animal Parasites

1—Trypanosoma is a flagellated parasite, found in Africa, in the blood of man and animals. Causes sleeping sickness. One or more nuclei; very motile

FIG. 15.—Trypanosoma

2—Negribodies, found in nervous system of animals dying of rabies. They are round, oval, hyalin bodies, contain nucleus

3—Coccidium oviforme; found in biliary passages and intestines; occur especially in rabbits

4—Ameba coli: spherical when quiet, moves by pseudopodia. Causes amebic dysentery and liver abscess. Inner part granular endoplasm, outer part clear ectoplasm

5—Malaria (Plasmodium Malariae). Carried by the Anopheles Mosquito

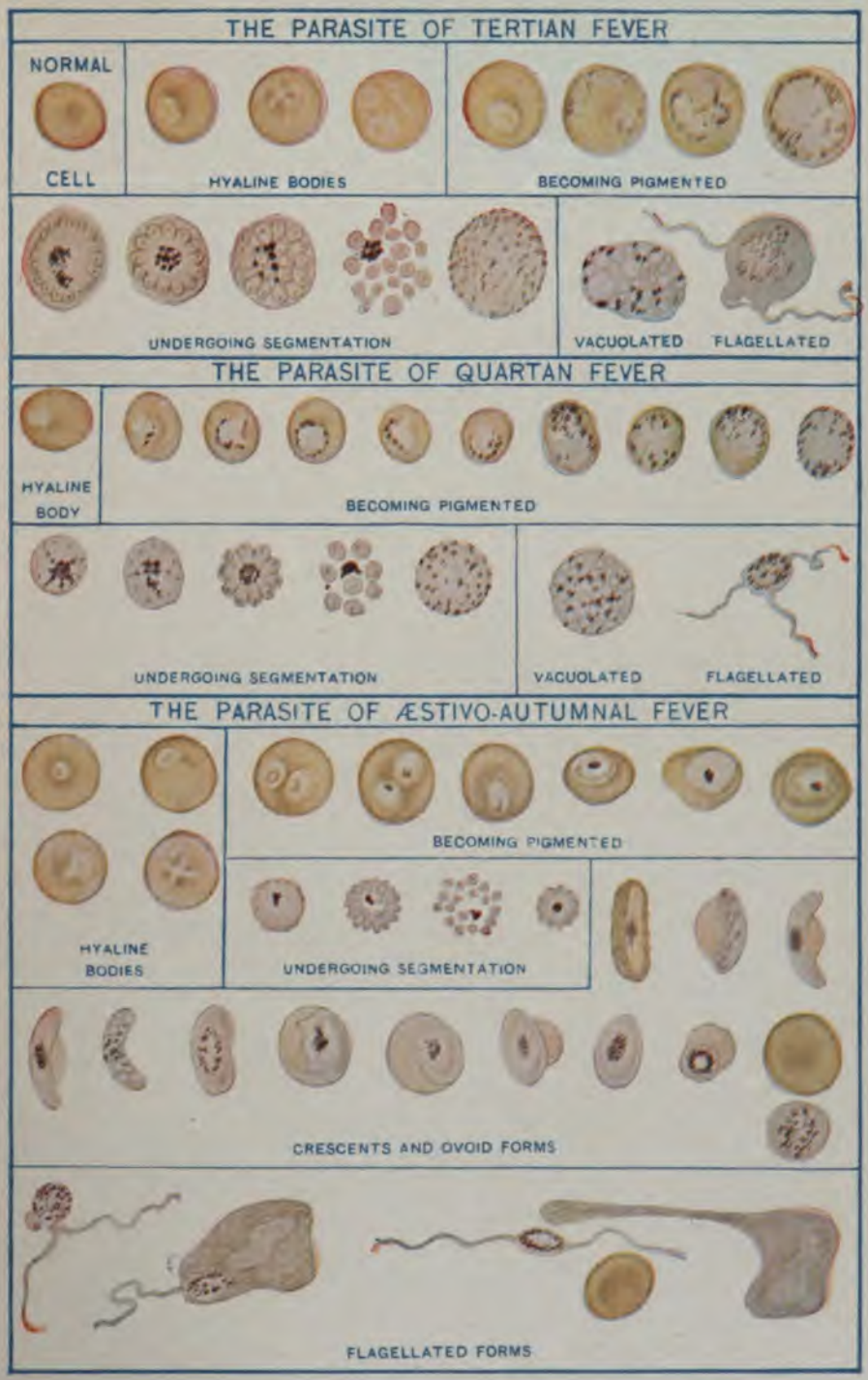
A—Tertian variety
B—Quartan variety
C—Estivo-autumnal type
a—Three stages
1—Hyalin bodies
2—Pigmentations
3—Sporozoids (Segmentation)
D—Differentiation

	TERTIAN	QUARTAN	ESTIVO-AUTUMNAL
a	Cycle in men 48 hours	Three days	Twenty-fou to 48 hours
b	Ameba in red cell active	Sluggish	Smaller than tertian
c	Decolorizes red cell rapidly	Slowly	Hemoglobin deeper in tint
d	Causes red cell to swell	Size preserved	Red cells shrivel
e	Outlines not sharply defined	Sharp	Not defined
f	Pigment in fine granules, abundant in motion	Coarser, fewer	Pigment in fine peripheral granules, not often in motion
g	Spores 15–20; usually 18; small	Larger, 6–12	Small; 6–30; usually 18
h	Flagella more numerous	No flagella	Less numerous
i	Ring forms common, early in the disease, more distinct than those of estivo-autumnal	Nothing special	Rings and disk forms are common; less distinct

C—BACTERIOLOGIC METHODS

I—To detect fecal contamination in drinking water
1—Revealed by finding typhoid and colon bacillus
2—Technique

PLATE V



THE PLASMODIUM MALARIÆ
SELECTED AND REPRODUCED FROM THAYER'S PLATES

To 3 test tubes containing 10 cc. of bouillon add 0.1 cc. of a solution containing: phenol, 5 gr.; hydrochloric acid, 4 gr.; distilled water, 100 cc. Add 1– cc. of water to each tube. Only typhoid and colon bacilli grow in this medium

II—To determine number of bacteria in drinking water or milk

Plate cultures are made on gelatin, agar, or glycerin-agar. The Petri dish placed on a large plate of glass divided into squares. Colonies counted and number of bacteria per cubic centimeter estimated

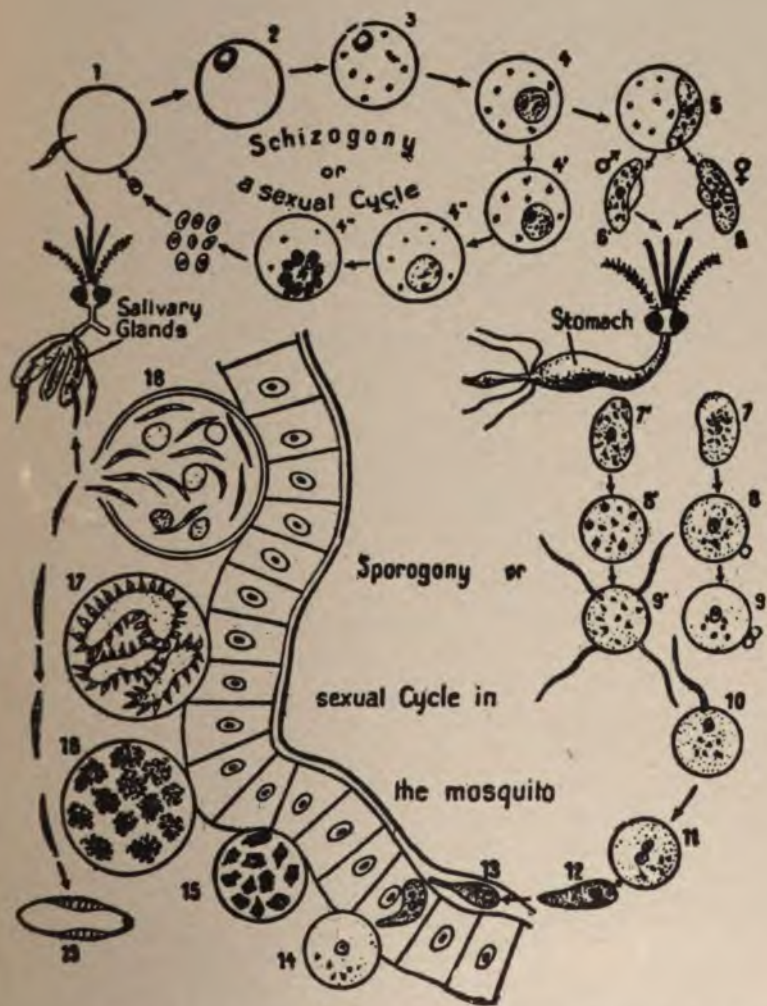


FIG. 1.—Evolution of the Plasmodium falciparum. Est., Stomach of the Anopheles; gl. sal. salivary glands (after Brumpt). 1, 2, 3, Schizonts. 4, Amœboid body. 4''', Rosette body. 5, 6, Gametes. 7-11, Fecundation. 12, Zygote. 15-18, Oöcysts.

SECTION II

PATHOLOGY

A—OUTLINE—Employed in describing pathological changes in an organ

I—Varieties or Stages
II—Pathologic Chemistry
III—Pathologic Physiology
IV—Morbid Anatomy
1—Cardinal Pathology
Gross
a—Size
b—Weight
c—Shape
d—Color
e—Surface
f—Capsule
g—Consistency
h—Cut section
1—Color
2—Surface
3—Scrapings
Microscopic
a—Parenchyma
b—Blood vessels
c—Stroma
d—Lymphatics
2—Associated Pathology
Systems
a—Gastro-intestinal
b—Circulatory
c—Respiratory
d—Nervous
e—Genito-urinary
1—Male
2—Female
f—Osseous
g—Muscular
i—Lymphatic

B—METHOD OF STUDY

I—Varieties or Stages
II—Pathologic Chemistry
III—Pathologic Physiology
IV—Morbid Anatomy
1—Cardinal Pathology
Gross
a—Size increased in acute, decreased in chronic inflammations
b—Weight, heavier than normal in acute, less in chronic inflammations
c—Shape, swollen in acute, distorted in chronic
d—Color, red in acute, slate in chronic inflammations
e—Surface, smooth in acute, granular in chronic inflammations
f—Capsule, strips with ease in acute, with difficulty in chronic inflammations
g—Consistency, softer than normal in acute, harder than normal in chronic inflammations
h—Cut section: in acute inflammations cuts with ease and drips blood; in chronic inflammations cuts with resistance
1—Color: red in acute, slate color in chronic inflammations
2—Surface: smooth in acute and granular in chronic inflammations
3—Scrapings: bloody or purulent in acute, scanty in chronic inflammations
Microscopic
a—Parenchyma
1—In acute cases
A—Proliferation
B—Exfoliation
C—Degeneration
Each cell is swollen, nucleus pushed to one side, protoplasm is granular and fails to stain.
2—In chronic cases
A—Fibroblastic infiltration and organization
b—Blood vessels
1—In acute cases
A—Dilatation of blood vessels
B—Acceleration
C—Retardation

D—Oscillation
E—Stasis and thrombosis
a—Extravasation of white blood cells by pseudopodia and red blood cells by diapedesis; exudation of the liquor sanguinis

V—Associated Pathology (of the infectious diseases)
1—Gastro-intestinal
Gastritis, gastro-enteritis, hepatitis and pancreatitis
2—Circulatory
Endocarditis, myocarditis, pericarditis, fatty degeneration of heart muscle, specific gravity of blood increased, alkalinity reduced; all the blood findings of a secondary anemia
3—Nervous
Meningitis, encephalitis, peripheral neuritis
4—Respiratory
Bronchitis, pneumonia, pleurisy, empyema
5—Genito-urinary
Nephritis, cystitis, albuminuria, casts, increased output of nitrogen
6—Osseous
Periostitis, osteomyelitis, arthritis
7—Muscular
Myositis
8—Lymphatic
Adenitis and lymphangitis, enlargement of the spleen

VI—Examples
1—In the text is given
Lobar Pneumonia
a—Stage of engorgement: The blood vessels are distended, epithelial cells lining the alveoli undergo parenchymatous degeneration; cells become swollen, nucleus pushed to the side, protoplasm granular and fails to stain, alveoli remain clear
b—Stage of Red Hepatization: Lung looks like red liver, the centers of the alveoli are filled with red cells, leukocytes, platelets and fibrin
c—Stage of Gray Hepatization
1—Gross
A—Looks like gray liver
2—Microscopic
A—Alveoli filled with leukocytes, red cells which have lost their hemoglobin, and fibrin

d—Stage of Resolution
1—Gross
A—Lung returns to normal
2—Microscopic
A—Fatty degeneration, liquefaction of exudate, some is absorbed, the remainder is expectorated

The student is expected to take it up in this manner in conjunction with outline given on first page of this subject, thus

2—Pathology of Lobar Pneumonia
Stages
a—Engorgement
b—Red hepatization
c—Gray hepatization
d—Resolution
Cardinal Pathology—Lung
a—Morbid Anatomy
***1*—Stage of engorgement**
Gross
***a*—Size, increased (because of congestion)**
***b*—Weight, heavier than normal (contains more cellular elements)**
***c*—Shape, swollen (size above normal)**
d—Color, red (engorgement)
e—Surface, smooth (no exudation into alveoli)
f—Consistency, somewhat harder than normal (cellular elements more closely packed)
g—Cut section, cuts with slight resistance, drips blood, color of cut section, red, surface smooth, scrapings bloody
Microscopic
a—Blood vessels dilated, stasis, no extravasation
b—Epithelium lining alveoli undergoes granular degeneration; each cell is swollen, nucleus pushed to one side, protoplasm granular, fails to stain
2—Stage of Red Hepatization
Gross

a—Size, increased
b—Shape, swollen
c—Weight, much heavier
d—Color, red
e—Surface, granular
f—Consistency, much firmer
g—Cut section, cuts with difficulty, surface granular, scrapings bloody

Microscopic

a—Blood vessels, distended; extravasation of liquor sanguinis; leukocytes by pseudopodia, red cells by diapedesis
b—Epithelium undergoes proliferation, exfoliation and degeneration
c—Alveolus filled with red cells, white cells and fibrin

3—Stage of Gray Hepatization

Gross

Same as red, only gray in color

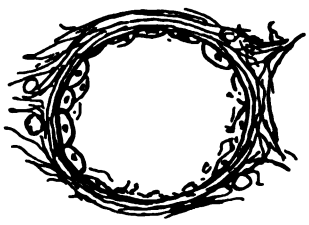


FIG. 17.—Engorgement.
Epithelium cells degenerated
Blood vessels dilated
Alveolae free

FIG. 17a.—Red Hepatization
Alveolus filled with
Red cells
Leukocytes
Degenerated epithelium
Mesh work of fibrin

FIG. 17b.—Gray Hepatization
Alveolus filled with
Principally white cells
Degenerated red cells
Epithelium
Mesh work of fibrin

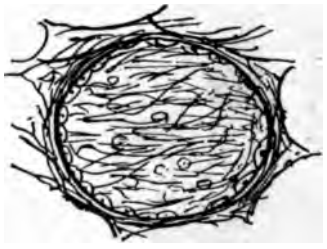


FIG. 17c.—Resolution
Fatty degeneration of exudate undergoing absorption

Microscopic

Same as red only erythrocytes have lost their hemoglobin, predominance of white cells

4—Stage of resolution

Gross

Gradually returns to normal

Microscopic

Fatty degeneration and liquefaction; some is absorbed, the rest expectorated

c—Associated Pathology

That of any acute infectious disease. Student is expected to insert associated pathology given on page 28.

Other Examples

Acute Parenchymatous Nephritis

Gross

a—Size, increased
b—Shape, swollen
c—Color, red
d—Capsule, strips with ease
e—Consistency, firmer
f—Cut section, cuts with slight resistance, color red, scrapings bloody

Microscopic

a—Parenchyma, proliferation, exfoliation, degeneration of the cells lining the uriniferous tubules, each cell swollen, nucleus pushed to one side, protoplasm, granular, fails to stain
b—Blood vessels, distended, engorged, extravasation of cellular elements

Chronic Interstitial Nephritis

Gross

a—Size, decreased, because of connective tissue contraction
b—Weight, less than normal
c—Shape, distorted, because of irregular contraction of connective tissue
d—Color, gray; contraction of connective tissue destroys the blood vessels
e—Surface, granular
f—Capsule, strips with difficulty
g—Consistency, cuts with resistance, color gray, surface granular, scrapings bloody

Microscopic

In a chronic inflammation, it is the stroma which is affected. There is an infiltration of fibroblasts which lengthen out and form fibers. These contract, causing a pressure, necrosis of epithelium, and converting blood vessels into a fibrous nodule

Note: Inflammation is same anywhere; only modified by structure in which it occurs.

GENERAL PRINCIPLES

A—DEFINITION

Pathology is the science which treats of the changes in structure and function in disease

B—CONSTRUCTIVE PROCESSES

I—Hypertrophy

Definition

Volumetric increase of an organ or tissue

Varieties

A—True—functional or compensatory, involves all parts of an organ, outline is preserved, function is increased

Cause

a—Increased function

b—Compensatory as result of loss of function of some other organ

B—False—involves connective tissue with atrophy of parenchyma, function diminished

Cause

1—Pressure

2—Trophic lesions

3—Disease of ductless glands

II—Hyperplasia—increase in number of cells

III—Metaplasia—conditions when one tissue assumes the function or character of another tissue

IV—Repair of Wounds

Definition

Process by means of which loss of tissue is repaired

Varieties

A—First intention: healing with small amount of connective tissue, usually no suppuration

B—Second intention: healing with large amount of connective tissue, suppuration usually is present

Anatomy

A—Wound is filled with blood clot

B—Formation of granulation tissue by budding from blood vessels called angioblasts; these unite with other angioblasts, tunnel out and form new blood vessels

C—Cicatricial tissue is formed by infiltration of connective tissue cells called fibroblasts; these lengthen out, form fibers, which contract and draw edges of wound together

D—Surface covered with epithelium

V—Thrombus

Definition

Clotting of blood in the blood vessels; during life, the clot remaining at the site of formation.

Cause

A—Disease of endothelial lining of blood vessels

B—Feeble circulation

C—Disease of the blood

D—Foreign bodies in vessel

Varieties

A—Red thrombus

Originates from the blood at rest, as after ligature of an artery. Consists of a loose network of fibrin which entangles very many red corpuscles and a few leukocytes

B—White thrombus

Originates from circulating blood, such as is found in an aneurysm; it is laminated and dense, composed chiefly of leukocytes

C—Parietal thrombus

Adheres to the vessel wall

D—Obstructive or obliterating thrombus

Obstructs the blood channel

Seat

Heart, arteries, capillaries, or veins

Changes in thrombus

A—Decolorization

B—Resolution

C—Organization

D—Calcification

E—Softening

Results

A—Inflammation of the vessel wall at site of thrombus

B—Obstruction to circulation

C—Embolism

VI—Dropsy
Definition
Accumulation of fluid in tissues or cavities of the body
Varieties
A—Edema
Effusion into connective tissue
B—Anasarca
Generalized edema
C—Ascites
Dropsy of peritoneal cavity
D—Hydrothorax, dropsy of thoracic cavity, etc.
Causes
A—Excessive flow of fluid from the vessels due to
a—Mechanical hyperemia
b—Relaxed states of blood vessels
c—Disease of the blood
d—Defective nerve supply
B—Defective absorption by the veins and lymphatics
Philosophy
Disturbance in amount of fluid that extravasates and amount taken up by the lymphatics
Symptoms
Painless swelling of skin; pale, smooth, shiny; pits on pressure
Description of effusion
Color: straw
Consistency: fluid
Chemical: albumin salts and fibrin factors absent
Clinical forms
Cardiac
Begins in feet and ankles
Obstructive
Location of edema depends on character of obstruction
Renal
Begins in eyelid
Nervous
Disturbance of vaso-motors, i.e., angioneurotic edema
Cachectic
Impaired nutrition
VII—Embolism
Definition
Plugging of blood vessels by a foreign body
Source

A—Emboli in pulmonary artery, come from v
side of heart
B—Emboli found in liver come from portal vein
C—Elsewhere in body come from arteries on left side
heart

Composition of embolus
A—Thrombus
B—Vegetations and calcareus plates
C—New growths
D—Fat
E—Air
F—Bacteria

Results
A—Infective
Infective inflammation resulting in abscess formation
B—Non-infective
a—Irritation followed by inflammation and softening
b—Local anemia
c—Infarction

VIII—Transudates

Definition
Extravasation of liquid from blood vessel, due to circulatory disturbances

Physical properties
Serous, straw-colored liquid
Does not coagulate, contains few cells, specific gravity 1.018, no bacteria present

IX—Exudates

Definition
Extravasation of liquid from the blood vessel as a result of inflammation

Physical properties
Serous, hemorrhagic or purulent
Coagulates, more cells, specific gravity more than 1.018, contains many bacteria

X—Infarction

Definition
Wedge-shaped infiltration of blood in an organ

Seat
Origin, organs having terminal vessels (end arteries)

Shape
Pyramidal

Varieties

A—White
From coagulative necrosis
B—Red
Passage of blood from neighboring capillaries
Termination
A—Absorption with formation of cicatrix
B—Liquefaction and cyst formation
C—Calcareus degeneration
D—Gangrene
XI—Blood pressure
Definition
Tension of blood in blood vessels
Maintained
A—Volume of blood
B—Size of vessel
C—Facility with which blood empties into the capillaries
D—Force of heart
High blood pressure
Cause
a—Increased cardiac action
b—Increased resistance in vessel walls
c—Increased peripheral resistance
Low arterial tension
Cause
a—Diminished cardiac force
b—Diminished peripheral resistance
Evidence
A—Incompressibility of the pulse
B—Accentuation of aortic second sound
C—Prolonged first sound, heart cannot send blood into vessel easily
D—Abundant urine
Result
A—Cardiac pain
B—Atheroma of vessels
C—Apoplexy

C—DESTRUCTIVE PROCESSES

I—Hypoplasia—defective development
II—Atrophy
Definition
Diminution in the size of an organ
Varieties
General—involvement of whole body

a—Defective nutrition (cancer of the esophagus)
b—Excessive waste (diarrhea)
c—Impaired vitality (senility)

Local—localized atrophy
a—Simple defective nutrition
b—Senile—physiologic
c—Brown—passive congestion with deposit of hemoglobin
d—Pressure—on organ or tissue
e—Neuropathic—lower neuronic lesion

Anatomy
A—Diminution in size and number of the parenchymal cells
B—Increase in connective tissue stroma

III—Degeneration—retrograde change in cell or tissue
1—Parenchymatous
Definition
Change in functioning part of organ, in which albuminous granules appear
Appearance
Cell swollen, granular, nucleus pushed to one side and stains with difficulty
Seat
a—Muscles, such as the heart
b—Glandular organs, liver and kidney
c—Connective tissue, inflammation of cornea
Cause
a—High temperature
b—Biologic toxins, such as occur in acute infections
c—Non-biologic toxins such as arsenic and phosphorus
Results
a—Impaired function
b—Return to normal state
c—Fatty degeneration

2—Mucoid and Colloid
Definition
a—In mucoid degeneration a substance is formed resembling mucus.
b—In colloid degeneration a jelly-like mass is formed
Seat
Mucoid
1—Epithelial cells lining mucous membrane in catarrhal inflammation
2—New growths: myxo-sarcoma, myxedema

Colloid
1—Tumors, malignant growths
2—Cartilage

3—Fatty Degeneration
Varieties
a—Fatty infiltration, fat formed outside of cell and deposited within the cell, no actual destruction of protoplasm
b—Fatty degeneration, fat formed within the cell; actual destruction of protoplasm
Appearances
Pale, yellow, and softened
Seat
a—Connective tissue
b—Liver tissue
c—Muscle
d—Blood vessels
Cause
a—Excessive fat diet
b—Sedentary life
c—Defective oxidation
d—Alcohol
e—Poisons
f—Lowered vitality
Termination
a—Softening
b—Calcareous degeneration
c—Cascation

4—Calcareous Degeneration
Definition
Deposit of calcareous matter in tissue
Appearance
Deposit of lime salts, rendering part hard, brittle and granular
Seat
a—Inflammatory exudates
b—Tumors
c—Coats of arteries
Cause
a—Previous disease
b—Old age
c—Fatty degeneration

5—Amyloid or Waxy Degeneration

Definition

Tissues undergo a waxy degeneration; cells become translucent and merge into each other, so that the outline is lost; organ firm and brittle; with tincture of iodin, produces a "mahogany" color

Seat

Liver, kidney, bowels and muscles

Cause

a—Prolonged suppuration
b—Syphilis
c—Malignancies

Test

Iodin and sulphuric acid turns tissue blue

Result

Permanent loss of function

Termination

Ends in death

6—Fibroid Degeneration

Definition

A type of degeneration consisting of atrophy of parenchyma and an increase of connective tissue

Appearance

Organ, small and hard

1—**Atrophy of parenchyma, then increase of connective tissue**

2—**Increase of connective tissue may be primary, and by pressure may cause secondary degeneration of parenchyma**

Seat

a—Liver
b—Kidney
c—Blood vessels
d—Nerve centers

7—Glycogenic Degeneration—protoplasm converted into glycogen.

8—Necrosis or Caries

Death of a mass of tissue, usually of bone, due to the interruption of blood supply. The dead fragment in place is called a sequestrum. The sequestra are eroded, irregular in outline and separated from the healthy tissue by a line of demarcation

IV—Gangrene

Death of tissue "en masse"

A—Dry gangrene
Cause
Blood prevented from entering freely
Description
The tissue becomes dark, friable, and horny; separated from the healthy tissue by a line of demarcation
B—Moist gangrene
Cause
Free access of blood to the part, defective drainage. Part is swollen, soft, pultaceous; color dark green or black, surface covered with blisters, odor characteristically offensive. The line of demarcation is the inflammatory line between the healthy and the diseased tissue

V—Anemia
General
Reduction in quality or quantity of blood
Local (Ischemia)
Definition
Diminution of blood supply to a part
Causes
a—Diminution in caliber of artery from
1—Disease of wall of blood vessel such as atheroma
2—Pressure on vessel
3—Plugging of blood vessel (embolus)
4—Contraction of blood vessel due to thermic or chemical stimulation
b—Dilatation of blood vessels in one part with a diminution in amount of blood elsewhere (collateral anemia)
Results
a—Pallor
b—Coldness
c—Defective nutrition
d—Collateral circulation
e—Infarction
f—Necrosis and gangrene
g—Softening

VI—Hyperemia
Definition
Increase of blood to a part

Classification

Active or arterial

Definition

Increase of arterial blood to a part

Etiology

***1*—Mechanical, thermic, and chemical irritation**

***2*—Nervous influences, stimulation of vaso dilators (neurotonic hyperemia) or paralysis of vaso-dilator nerves (neuro-paralytic)**

***3*—Obstruction in the circulation of a neighboring organ or part (collateral hyperemia)**

Passive or venous

Definition

Excess of blood in capillaries and veins

Cause

***1*—Anything that diminishes the vis-a-tergo, as**

A—Weakness of heart

B—Impediment to circulation

C—Pressure on capillaries

D—Interference with valves of veins

***2*—Interference of blood in veins**

A—Pressure on vein

B—Plugging of vein by a thrombus

C—Diseases of heart

D—Pulmonary disease

Results

1—Diminished velocity of blood current

2—Transudation of serum

3—Escape of erythrocytes

4—Hemorrhage

5—Fibroid induration

6—Thrombosis

7—Necrosis or gangrene

8—Atrophy

9—Collateral circulation

10—Diminished heat

11—Livid color

12—Diminished function

VII—Leukemia

Definition

A primary anemia due to disease of the blood-forming organs characterized by leukocytosis and pathological changes in bone marrow and spleen.

VIII—Leukocytosis

Definition

Increase in the number of leukocytes in the blood

Varieties

A—Physiological

Digestion, exercise, pregnancy and the first day of life

B—Pathological

All acute infectious diseases except six

T.T.—Typhoid and Tuberculosis

M.M.—Measles and Malaria

G.G.—Grip and German Measles

Significance

A—Lymphocytosis—indicates a chronic retrograde process such as tuberculosis

B—Polynuclear neutrophilic leukocytes—indicates active acute suppuration

C—Eosinophilic leukocytosis—indicates

a—Bronchial asthma

b—Skin disease

c—Parasites

D—Basophilic leukocytosis—indicates chemical intoxication, such as lead poisoning

IX—Hemorrhage

Definition

Escape of blood from a blood vessel due to a loss of continuity of vessel wall

Classification

As to cause

Hemorrhage per rhexis, rupture of a vessel

Hemorrhage per diapedesis, loss of blood through vessel wall, without rupture

As to size

Petechia—small subcutaneous hemorrhage

Ecchymosis—larger subcutaneous hemorrhage

Hematoma—tumor of blood beneath the skin

As to location

Epistaxis—bleeding from the nose

Hematemesis—bleeding from the stomach

Metrorrhagia—bleeding from the uterus between the menstrual periods

As to time

Primary—immediate

Intermediate—within the first 48 hours

Secondary—after 48 hours

Changes in extravasated blood
- A—Coagulation
- B—Organization
- C—Cyst formation
- D—Suppuration
- E—Calcification

X—Inflammation

Definition

Reaction of living tissue to injury, provided the injury is not severe enough to destroy the tissue outright

Etiology
- A—Mechanical
- B—Chemical
- C—Thermic
- D—Electrical
- E—Bacterial and parasitic

Pathology

Varieties
- a—Catarrhal—inflammation of mucous membrane
- b—Fibrinous—deposit of membrane on the surface
- c—Diphtheritic—formation of a membrane within the tissue
- d—Serous—exudation of serum
- e—Purulent—exudation of pus
- f—Parenchymatous—involves the functioning part of a gland
- g—Interstitial—involves the stroma or supporting structure

Philosophy

A constructive process: for the following reasons
- *1*—Brings greatest nutrition to part
- *2*—Brings greatest number of leukocytes
- *3*—Extravasation of liquor sanguinis dilutes the toxins

Morbid Anatomy

Blood vessels
- *1*—Dilatation of blood vessels
- *2*—Acceleration of blood flow
- *3*—Retardation
- *4*—Oscillation
- *5*—Stasis
- *6*—Thrombosis
- *7*—Exudation

A—Leukocytes by pseudopodia, advance guards
B—Red cells migrate by diapedesis
C—Liquor sanguinis, inflammatory edema

Tissue changes
Proliferation
Exfoliation
Degeneration
Each cell is swollen, the nucleus is pushed to one side, the protoplasm is granular and fails to stain

Termination of inflammation
1—Resolution—returns to its former state
2—Local destruction of tissue
A—Suppuration
B—Ulceration
C—Gangrene
D—Organization
E—Chronic

Symptoms
Local
A—Pain
B—Redness
C—Swelling
D—Heat
E—Impairment of function
General
Symptoms of fever with specific phenomena belonging to special type of intoxication

Treatment—Acute
1—Local
A—Remove exciting cause
B—Rest, physical and physiological
C—Reduce the blood pressure
a—Elevation
b—Leeching
c—Incision
d—Cold and heat
D—Prevent fresh source of infection
2—General
A—Antiphlogistics
B—Counter irritants
C—Tonics
D—Alteratives

Treatment—Chronic
1—Remove cause
2—Rest
3—Counter-irritation
A—Friction
B—Iodin
C—Massage
4—General constitutional treatment
5—Vaccination

XI—Definitions
1—Abscess
Circumscribed collection of pus in a cavity of new formation, composed of two zones
a—Inner zone composed of liquefied tissue, pus and necrotic tissue
b—Outer zone of inflammatory exudate
2—Phlegmon
Diffuse purulent infiltration of tissue
3—Ulcer
Localized area of suppuration on a free surface with tissue destruction
4—Fistula
Suppurating canal connecting a body cavity with another cavity or connecting a cavity with a free surface
5—Sinus
Canal connecting a newly formed cavity (abscess) with another newly formed cavity or with the surface
6—Empyema
Collection of pus in a preëxisting cavity

XII—Tumors
Definition
New formation, without physiological function and with no typical termination
Etiology
Predisposing
a—Age—connective tissue tumors are most common in early life, malignant epithelial tumors late in life
b—Sex—little bearing, except in the case of cancer, which is more common in females
c—Heredity—some importance
Exciting
a—Cohnheim's theory—portions of tissue misplaced in embryo

b—Parasitic and bacterial
c—Ribbert's tension theory
Disturbances in surrounding tension
d—Irritation and heredity
Classification
A—Clinical
Benign
1—Do not disturb the general health
2—No tendency to recurrence
3—No metastasis
4—Remain within the tissue in which they originate
Malignant
1—Affect the general health
2—Recur after removal
3—Metastasis
4—Break through the limits of the parent tissue and invade the surrounding structure
B—Histological
a—Connective tissue
1—Fibroma—fibrillar connective tissue
2—Myxoma—mucous tissue
3—Sarcoma—embryological connective tissue
4—Endothelioma—endothelial tissue
5—Lipoma—fat tissue
6—Chondroma—cartilage tissue
7—Osteoma—bone tissue
8—Glioma—neuroglia tissue
b—Muscle tissue
1—Leiomyoma—smooth muscle tissue
2—Rhabdomyoma—striated muscle tissue
c—Nerve tissue
1—Neuroma
d—Vascular tissue
1—Angioma—blood vessels
2—Lymphangioma—lymph vessels
e—Epithelial tissue
1—Adenoma—gland structure
2—Carcinoma—epithelial tissue
C—According to tissue which is the prototype of the cells that compose the tumor
a—Parablastomata, or connective-tissue tumors
Examples
A—Fibroma—adult type

B—Sarcoma—embryonal type

b—Archiblastomata, or tumors after the type of specialized tissue

Examples

A—Epithelioma

B—Adenoma

C—Papilloma

D—Endothelioma

E—Myoma

F—Neuroma

c—Teratomata—mixed tumors

1—Dermoid cyst

D—Classification of cysts

a—Retention due to occlusion of the excretory ducts

b—Exudation—accumulations in closed cavities

c—Cystomata—new formations

d—Extravasation—those forming from extravasations

e—Dermoid—congenital and due to inversion of the cutis and to imperfectly closed fetal clefts

f—Parasitic due to animal parasites

E—Individual characteristics

a—Fibroma—benign tumors of slow growth consisting of fibrous tissue and few blood vessels

1—Hard (Epulis polypus) few cells, much intercellular substance

2—Soft—less intercellular substance, more cells

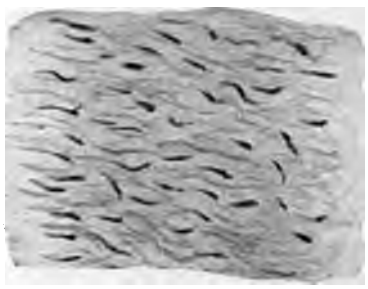


FIG. 18.—Hard Fibroma

FIG. 19.—Myxoma

3—Uterine fibroids

Three varieties

a—Submucous—beneath the mucous membrane

b—Interstitial—within the muscle

c—Subperitoneal—beneath the peritoneal tissue

b—Myxoma—tumors composed of gelatinous basement substance containing spheroidal cells

c—Sarcoma—a tumor of embryological connective tissue cell origin, containing many blood vessels; metastasis takes place through blood

Classification

As to cells

a—Round cell
b—Spindle cell
c—Giant cell
d—Mixed cell

As to stroma

a—Fibro-sarcoma
b—Myxo-sarcoma
c—Chondro-sarcoma
d—Osteo-sarcoma

As to secondary changes

a—Melano-sarcoma
b—Lipo-sarcoma
c—Chloroma

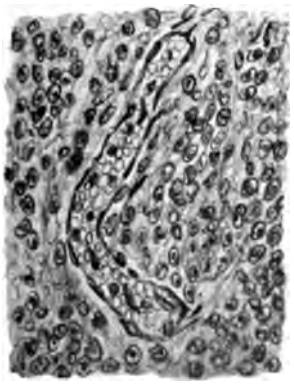


FIG. 20.—Small Round-celled Sarcoma

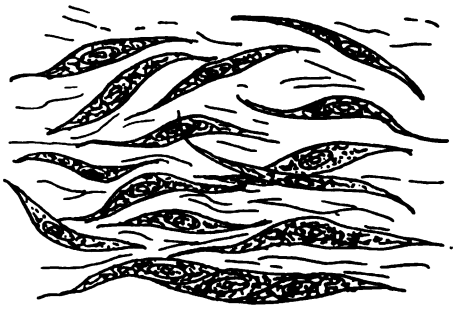


FIG. 21.—Cells from a Large Spindle-celled Sarcoma

FIG. 22.—Lymphosarcoma of Nasal Mucous Membrane

d—Carcinoma—tumor composed of epithelial tissue

Classification

A—Histological

a—Squamous
b—Cylindrical
c—Glandular

B—Clinical

a—Scirrhus
b—Encephaloid
c—Colloid

d—Melanocarcinoma

C—Description

a—Epithelioma, squamous-celled carcinoma arranged in solid plugs, embedded in connective tissue. The cells in the center are arranged in whorls called Epithelial Pearls: looks like a cross-section of an onion

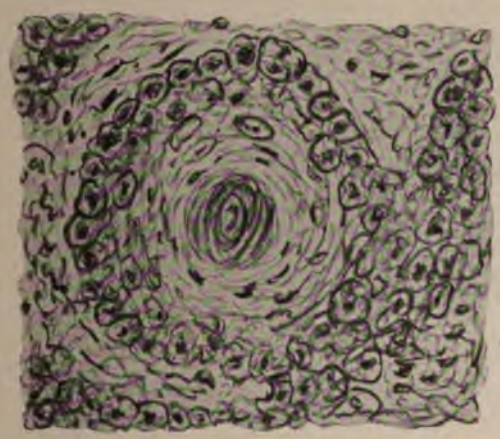


FIG. 23.—Epithelioma of Skin, Showing Concentric Arrangement

b—Adenoma, mimic of gland in structure but not in function

c—Papilloma, enlarged papillae covered with epithelium. They are wart-like polypoid, cauliflower-like in appearance

e—SARCOMA	CARCINOMA
1—Origin, embryonic connective tissue type	*1*—Epithelial tissue type
2—Heredity, slight importance	*2*—More important
3—Age, before middle age	*3*—After middle life
4—Injury, no etiologic factor	*4*—Irritation, etiologic factor
5—Cells, embryonic connective tissue cells	*5*—Epithelial cells within alveoli
6—Stroma, does not form alveoli	*6*—Forms alveoli

7—Vessels, embryonic in character. They are in direct contact with the tumor cells	7—Well developed, not in contact with the cells
8—Site, deep structures from connective tissue	8—Site, superficial structure from epithelium
9—Spreads by blood vessels	9—Spreads by lymphatics
10—Secondary changes A—Calcific B—Pigmentary C—Chondroid D—Osseous	10—Secondary changes rare
11—Growth, interrupted	11—Rapid, continuous
12—Fat, none	12—Contains fat

f—Lipoma

Tumor composed of fat cells; rounded, lobulated, encapsulated tumors; consistency varies with the amount of connective tissue

g—Myoma

Tumor composed of muscle cells

DISEASES OF RESPIRATORY SYSTEM

A—PNEUMONIA

Definition

Inflammation of lung

Varieties

Acute

A—Lobar

Exudative in type

B—Lobular

Productive type

C—Abscess

Destructive in type; secondary infection

D—Gangrene

Destructive in type; secondary infection with saprophytes

E—Hypostatic

Mildly exudative

Chronic

A—Interstitial, productive in type

2—Group due to physical irritation; **pneumonoconiosis**

C—Tubercular
D—Syphilitic
E—Heart disease

B—ACUTE INFLAMMATION

I—Lobar Pneumonia (Croupous)
Definition
Inflammation, lobe of lung
Etiology
Pneumococcus Fraenkel
Nature
Exudative, productive; inflammation spreads blood vascular system
Anatomy
A—Engorgement
a—Gross
Acute inflammation fits outline
b—Microscopic
Blood vessels distended, no extravasation, thelium lining of the alveoli degene center of alveoli free
B—Red Hepatization
a—Gross
Like liver
b—Microscopic
1—Extravasation of cellular element within alveoli
2—Proliferation and exfoliation of epithelium falling into alveoli, which are filled with red cells, white cells and desquamated epithelium
3—Gray Hepatization
A—Gross
Like gray liver
B—Microscopic
Red cells lose hemoglobin, white cells predominate
4—Resolution
A—Gross
Return to normal
B—Microscopic
Liquefaction of exudate, some of which is absorbed and the rest expectorated

II—Bronchopneumonia (Lobular, Catarrhal, Capillary Bronchitis)
Definition

Inflammation of a lobule of lung
Etiology
Irritant, milder than lobar pneumonia
Streptococcus
Staphylococcus
Nature
Begins as a bronchitis, travels by lymphatics or air vesicles to alveoli
Histology
Gross
Irregularly mottled, edematous signs of inflammation in both lungs
Microscopic
Involves lobule, epithelium of bronchiole degenerated, mucosa and submucosa infiltrated with inflammatory cells, alveoli in center filled with productive and exudative inflammation. In outer alveoli, inflammation not so marked, and are filled with epithelial and connective tissue cells

III—Hypostatic congestion
Etiology
Obstruction to circulation
Anatomy
Dependent part of lung dark, full of blood, edematous with scattered patches of bronchopneumonia

IV—Abscess
1—Pyemic
2—Secondary to lobar and Broncho Pneumonia
A—Anatomy
Pyemic
Multiple, swollen, widely distributed near surface
Secondary
Larger, single or few in number
B—Routes of infection
a—Blood current
b—Bronchi
C—Histology
a—Central area of pus surrounded by
Layer of degenerated cells
Layer of granulation tissue
Layer of connective tissue

V—Gangrene
Cause
Infection in area of lung where nutrition is cut off by

thrombus or embolous aneurysm. Recognized by
a—Odor
b—Color

VI—Tuberculosis (Phthisis)

Definition

Inflammation of lung caused by tubercle bacillus, interstitial in character, tendency to become localized. Phthisis is tuberculosis plus pneumonia

Varieties

A—Acute—tuberculous pneumonic phthisis (Galloping consumption)
a—Pneumonic
b—Bronchopneumonic
B—Chronic ulcerative
C—Fibroid

Morbid Anatomy

A—Tubercle Pneumonic Phthisis
a—Pneumonic Phthisis
Gross
Same as lobar pneumonia plus cavity formation, bronchogenous in origin
Microscopic
Formation of tubercle made up of following zones from within outward
a—Tubercle Bacilli
b—Giant cells
c—Epithelioid cells
d—Plasma cells
e—Fibrous tissue capsule

b—Bronchopneumonia
Gross
Caseous Bronchopneumonia
Microscopic
Catarrhal Pneumonia

B—Chronic Ulcerative Tuberculosis
Cardinal Lesions
1—Miliary Tubercles
A—Aspiration of tuberculous material situated in air cell or walls of smaller bronchi
B—Dissemination by lymph current. Tubercles scattered about and form in radial manner
2—Tuberculous Pneumonia
3—Cavities (Vomica)

A—Fresh ulcerative
Acute phthisis, no limiting membranes, soft caseous wall
B—Well-defined walls
C—Quiescent cavities
4—Tubercular Pleurisy

VII—Chronic Inflammation
1—Chronic interstitial pneumonia
Definition
Chronic inflammation of interstitial tissue of lung
Etiology
Mild irritation, long continued
Physiology
Connective tissue hyperplasia
Anatomy
Gross
Small, pale, firm, thick; pleura opaque; cross section cuts with resistance
Microscopic
Connective tissue bands
2—Pneumonia associated with Heart Disease (Brown induration)
Etiology
Diseased mitral and aortic valves
Philosophy
Leak causes increased pressure in lung, obstructing circulation of air; decreased nutrition producing a mild irritation
Anatomy
Gross
Lung brown, heavy, and cuts with resistance
Microscopic
Increased connective tissue, destruction of red cells with liberation of hemoglobin
3—Anthracosis, siderosis, silicosis
Definition
Interstitial pneumonia caused by inert irritating particles
Etiology
Miners, stone masons
Pathology
Same as chronic interstitial pneumonia

VIII—Acute Bronchitis
Etiology

Mechanical and bacterial irritation

Nature of Process

Acute, exudative, productive, inflammation

Anatomy

Lung congestive and edematous

Gross

Cut section: serum oozes, bronchial wall thickened, covered with a tenacious mucus

Microscopic

Blood vessels distended, round celled infiltration

Sequelae

A—Resolution

B—Chronic

IX—Atelectasis

Definition

Collapse of lung

a—Imperfect expansion after birth

b—Penetrating wound

c—Plugging of a bronchus

X—Bronchiectasis

Definition

Dilatation of a bronchiole with atrophy of the wall

XI—Emphysema

Definition

Over-distention of the lung or to make good a loss of respiratory capacity

Pathology

A—Vesicular

Vesicles dilate and communicate with each other

B—Interstitial

Air between alveolar walls

XII—Pleurisy

Note—This is a general description applicable to all membranes. Wherever a serous membrane is involved it undergoes four types of inflammation

A—Serous

B—Fibrinous

C—Serofibrinous

D—Purulent

Gross

Membrane loses its bright and glistening color, becoming opaque and dull; assumes the appearance of a tarnished mirror; becomes covered with a layer of fibrin

Microscopic

A—Blood vessels distended, extravasation of cellular elements. Proliferation, exfoliation and degeneration of endothelial cells

DISEASES OF CIRCULATORY SYSTEM

A—ACUTE PARENCHYMATOUS DEGENERATION OF HEART

Etiology

Biologic toxins

Non-biologic toxins

Philosophy

Toxins change the chemistry of protoplasm, with a deposition of granules and absorption of water from tissues

Anatomy

Gross

Muscle soft, friable, loses red color

Histology

Fibers swollen, granular, nuclei obscure

B—FATTY INFILTRATION OF HEART

Philosophy

Body stores hydrocarbons over myocardium; when fat gets into muscles it produces pressure disturbance

Anatomy

Gross

Heart large, covered with fat and flabby

Histology

Cells become swollen; cell has the appearance of a signet ring

C—HYALINE DEGENERATION OF HEART

Philosophy

Weakened condition of muscles, strain causes it to rupture, undergoes hyaline degeneration

Histology

Cells homogeneous, shining, refractile

D—ENDOCARDITIS

Definition

Inflammation of endocardium

Varieties

1—Acute

A—Simple
B—Ulcerative
2—Chronic
Etiology
Bacterial
Philosophy
Irritation results in the production of connective tissue; an endocardial mass is formed which projects into the lumen with slowing of the current over the projection. Production of coagulation and organization causes a vegetation. Vegetation may fall off and be carried as emboli by the circulation, ulceration takes place
Anatomy
Gross
Endocardium edematous; appearance of friable vegetations over valves; may separate leaving small ulcers
Histology
Vegetation made up of leukocytes, red cells and connective tissue cell infiltration

E—*CHRONIC ENDOCARDITIS*
Anatomy
Gross
Heart fatty and sclerotic; undergoes dilatation and hypertrophy; vegetation situated on ventricular side of the aortic and on auricular side of the mitral valve
Histology
Chronic productive, infiltration

F—*BROWN ATROPHY OF THE HEART (PIGMENTATION OF THE HEART)*
Philosophy
Due to disturbed nutrition, heart returns to embryonal form; pigmentation of muscle
Anatomy
Gross
Small, flabby, brown in color
Histology
Cells granular and pigmented (called "Schultze's Corpuscles")

G—*HYPERTROPHY OF HEART*
I—True—Volumenteric
II—False—Numerical

H—SCLEROSIS OF CORONARY ARTERIES

Results in
- Angina pectoris
- Neuralgia
- Fatty degeneration
- Sclerosis

I—ARTERIOSCLEROSIS

In arteriosclerosis it is the inner coat which is affected; this becomes thickened by layers of fibrous tissue owing to the proliferation of the subendothelial connective tissue cells. The elastic layer becomes granular, and it may be partially destroyed. Where high arterial tension exists the media is affected and the muscle fibers become hypertrophied; the vessels increase in length and thickness, becoming tortuous and infiltrated with calcium salts

J—ANEURYSM

Definition
- Dilatation of a blood vessel to form a sac containing blood and communicates with interior of the blood vessel

Classification
- True
  - A—Sacculated
    - Localized distention
  - B—Cylindrical and fusiform
    - Entire periphery bulges
  - C—Dissecting
    - Blood dissects between coats
  - D—Miliary
    - Multiple and numerous
  - E—Cirsoid
    - Vessels tortuous
- False
  - A—Varicose aneurysm
    - Communication between artery and vein with sac intervening
  - B—Aneurysmal varix
    - Communication between artery and vein, no sac intervening

K—VARICOSE VEIN

Philosophy
- Occurs in veins which are under gravity pressure

Anatomy

Veins tortuous, firm, with irregular dilatation; patches of calcification

GASTRO-INTESTINAL DISEASES

A—STOMATITIS

Definition

Inflammation of mouth

Etiology

Irritation

Pathology

Varieties

A—Acute catarrhal

Pathology—that of any inflamed membrane

B—Aphthous

Small vesicles which rupture leaving ulcers; grayish base, red margin

C—Ulcerative

D—Parasitic (Thrush)

Cause: Oidium albicans; forms pearly white spots, imbedded in which is the parasite

E—Gangrenous (Cancrum oris: Noma)

Rapidly spreading gangrene following infectious disease

F—Mercurial

Swollen gums, salivary glands enlarged, increased saliva, teeth loosened

Definitions

1—Geographical tongue

Desquamation of epithelium in circinate patches

2—Leukoplakia buccalis

A—Small white spots—lingual corns

B—Diffuse thickening of epithelium

3—Ptyalism

Supersecretion of saliva

4—Xerostomia

Arrest of salivary and buccal secretion

5—Angina Ludovici

Grave cellulitis of neck

6—Mikulicz's disease

Enlargement of salivary and lacrymal glands

B—ACUTE GASTRITIS

Etiology

Irritants

Gross

Mucous membrane covered with mucus; swollen and irregular

Microscopic

Abundant round celled infiltration, blood vessels distended, inflammatory induration

C—CHRONIC GASTRITIS

Gross

Organ enlarged; mucous membrane pale gray, covered with mucus. Wrinkling of mucous membrane. May undergo complete atrophy

D—ULCER

Philosophy

Blocking of an artery which deprives the stomach of a triangular area of nutrition and allows gastric juice to digest mucosa of the stomach

Anatomy

Gross

Single, small, situated on posterior surface or lesser curvature. Punched out appearance. No elevation of edges. Local peritonitis

Microscopic

Round cell infiltration

Associated Pathology

A—Perforation

B—Hemorrhage

C—Stenosis

D—Hour glass contraction

E—Perigastric adhesions

E—CARCINOMA

Anatomy

Same as carcinoma elsewhere

F—ACUTE ENTERITIS

Gross

1—Mucous membrane is injected; color red or brown
Mucosa swollen and soft

2—Covered with mucus

Microscopic
Vascular distention
Round cell infiltration

G—DYSENTERY

I—Catarrhal—congestion, swelling, edema, petechiae, and ulcers
II—Ulcerative due to Ameba coli—the mucosa is swollen, covered with ulcers, ragged edges, undermined base. THIS CONDITION IS ASSOCIATED WITH ABSCESS OF THE LIVER
III—Diphtheritic—the walls are covered with grayish false membrane, may be gangrenous in the severe form

H—APPENDICITIS

I—Catarrhal form
Slight swelling and congestion of the mucous membrane and retention of the contents of the appendix
II—Gangrenous form
Mucosa is destroyed; local peritonitis with adhesions; rupture of appendix and peritonitis
III—Interstitial appendicitis
Production of connective tissue; thickening of interstitial coat

I—PERITONITIS

Peritoneum is injected, lusterless, covered with lymph; exudate is serous, later becomes purulent, tends to become localized by adhesions

J—LIVER

I—Cirrhosis
Definition
Disease of the liver, characterized by increase in connective tissue
Varieties
Atrophic
Gross
Size, reduced
Shape, deformed
Weight, reduced
Surface, hob-nailed
Consistency, firm
Cuts with resistance
Microscopic
1—Destruction of liver cells
2—Obstruction of the portal circulation by broad

bands of connective tissue, which surround the lobule

Hypertrophic

Gross

Organ, enlarged

Surface, smooth

Consistency, increased

Microscopic

Hyperplasia of the connective tissue

Angiocholitis: liver cells undergo active hyperplasia, connective tissue diffused through organ, intralobular instead of interlobulous as in atrophic cirrhosis

II—Abscess of Liver

Etiology

A—Infection by way of the bile-ducts or from the duodenum

B—Extension from contiguous organs

C—Traumatic

D—Amebic

Amebic abscess is usually single; both amebic and pyogenic microörganisms are present

E—Pyemia

Pyemic or metastatic abscesses are multiple; the primary focus is a pylephlebitis

Anatomy

Single, or multiple project above surface, peritoneal adhesions bind it to diaphragm. May open into respiratory or abdominal viscera

K—KIDNEY

I—Acute parenchymatous nephritis. Fits outline

II—Chronic interstitial nephritis. Fits outline

III—Suppurative pyelonephritis

Anatomy

Gross

Large, red, moist, friable, may be cystic; capsule strips easily; pelvis dilated, cavity filled with pus, ureters widely dilated

Microscopic

Abscess formation

IV—Waxy kidney

Etiology

Prolonged suppuration

Pathology

Hyaline degeneration of blood vessels

V—Hydronephrosis

Distention of pelvis of the kidney with water. Atrophy of kidney substance

VI—Casts

1—Hyaline

Tube-casts consisting of an albuminous material resembling the substance formed in amyloid and hyaline degeneration. Waxy casts are a special variety. They are found in chronic interstitial nephritis

2—Cellular—Hyaline casts with cells or cellular débris attached

a—Epithelial

b—Blood

c—Pus-casts

They signify parenchymatous nephritis

3—Granular—Degenerated cellular, especially epithelial casts. They signify chronic disease; when abundant, chronic parenchymatous nephritis

VII—All cysts of the kidney are due to developmental error, or lack of union between convoluted and straight tubules

1—Retention cysts, occurring in contracted kidney

2—Solitary cysts, supposed to be due to the coalescence of a number of small cysts

3—Hydatid cysts

4—Congenital cystic kidney, in which the kidneys may be very large and the parenchyma replaced by numerous large multilocular cysts

5—Hydronephrosis, a condition resulting from ureteral obstruction, and sometimes classified among the cysts of the kidney

DISEASES OF THE BLOOD

A—SECONDARY ANEMIA

Definition

Anemia due to some definite cause

A—Inanition

B—Infection

C—Intoxications

D—Hemorrhage

E—Albuminous drains

B—PRIMARY ANEMIA

Definition

Anemia of unknown causation

Pathology

1—Chlorosis

Red cells

a—Average 4,000,000 and rarely under 2,000,000. Poikilocytosis. Many microcytes

b—Normoblasts

Occasional

c—Megaloblasts

Rare

d—Hemoglobin

40% ; color index always low

White cells

Number 8,000–10,000

1—Small lymphocytes—30%

2—Large lymphocytes—12%

3—Polymorphonuclear—55%

4—Eosinophils—normal

5—Myelocytes—absent

Cardinal features

1—Slight reduction of red cells

2—Absence of megaloblasts

3—Low color index

2—Pernicious Anemia

Red Cells

A—Average 1,000,000 microcytes and megalocytes present

B—Normoblasts

Numerous

C—Megaloblasts

Predominate over the normoblast

D—Hemoglobin

Color index high

White Cells

A—Usually decreased (5,000–7,000)

B—Small lymphocytes 30%

C—Large lymphocytes 12%

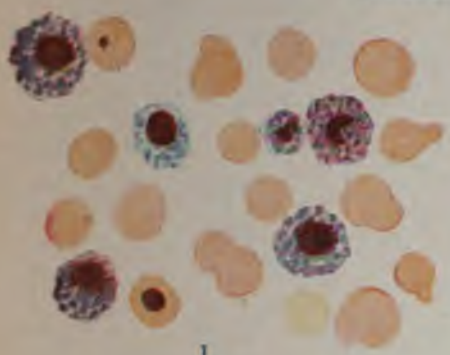
D—Polymorphonuclear 55%

E—Eosinophils

Normal

F—Myelocytes: variety eosinophilic

PLATE VI



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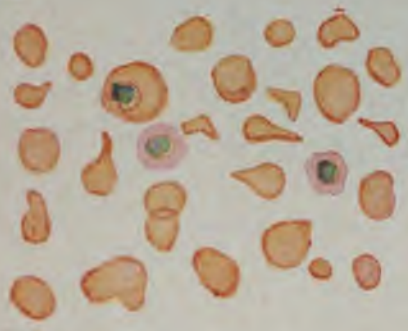

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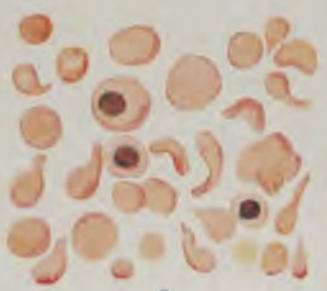

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Fig. 1.—Lienomedullary leukemia.
Fig. 2.—Pernicious anemia.
Fig. 3.—Chlorosis.
Fig. 4.—Blood in splenomedullary leukemia—several myelocytes (mononuclear neutrophiles), one polynuclear neutrophile, one eosinophile—one nucleated red cell—one lymphocyte, stained with Ehrlich's Triple mixture.
Fig. 5.—Blood in pernicious anemia, showing irregularity in size and shape of erythrocytes; one megaloblast (nucleated red cell)—and two leukocytes,—stained with Ehrlich's Triple mixture.

Cardinal features

A—Great reduction in red cells
B—Predominance of megaloblasts
C—High color index

3—Secondary Anemia

Red Cells

A—May be 2,000,000 or 3,000,000. Small poikilocytes
B—Normoblasts
Common
C—Megaloblasts
Rare
D—Hemoglobin
Color index low

White cells

A—Number 10,000–12,000
B—Small lymphocytes 20%
C—Large lymphocytes 2%
D—Polymorphonuclear 75%
E—Eosinophils
Normal
F—Myelocytes
Rare

Cardinal features

A—Moderate reduction in red cells
B—Predominance of normoblasts
C—Low color index

4—Pathological Leukocytosis

Red cells

A—2,000,000–3,000,000
B—Normoblasts present
C—Megaloblasts present
D—Hemoglobin
Low color index

White Cells

A—Number up to 50,000
B—Small lymphocytes 7%
C—Large lymphocytes 3%
D—Polymorphonuclear 90%
E—Eosinophils 1%
F—Myelocytes present

Cardinal features

A—Red cell count of a secondary anemia
B—Leukocytosis

C—Polynuclear Leukocytes 90%

5—Myelocytemia or splenomyelogenous leukemia

Red cells

A—2,000,000 to 3,000,000

B—Normoblasts

Present

C—Megaloblasts

Present

D—Hemoglobin

Normal or relatively decreased

White cells

A—Average 450,000

B—Small lymphocytes, diminished 5.5%

C—Large lymphocytes 2%

D—Polymorphonuclear 50%

E—Eosinophils 2%

F—Myelocytes 35%, characteristic

Cardinal features

A—Red cells: change as in a secondary anemia

B—Great increase in white cells

C—Myelocytes present to 35%

6—Lymphemia or lymphatic leukemia

Red cells

A—2,000,000–3,000,000

B—Normoblasts; rare

C—Megaloblasts; rare

D—Hemoglobin; diminished low color index

White cells

A—Average 100,000 or less

B—Small and large lymphocytes 90%

C—Polymorphonuclear

Average only 3%

D—Eosinophils

Scanty, average 0.7%

E—Myelocytes

Scanty, average 0.3%

Cardinal features

A—Red cells: count that of a secondary anemia

B—Increase of white cells to 100,000

C—Lymphocytes average 90%

7—Hodgkin's disease

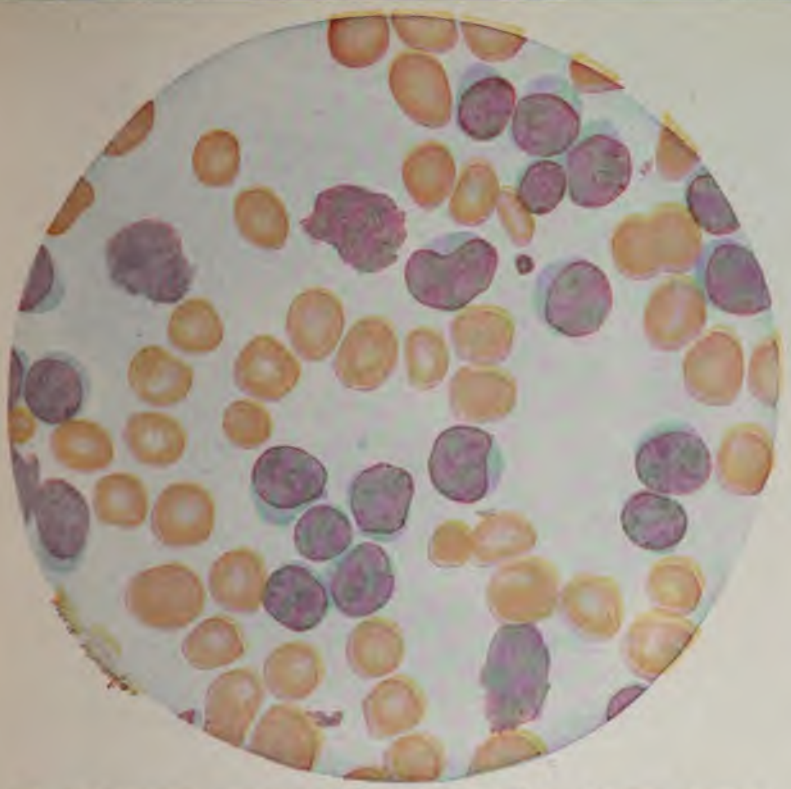


Fig. 1.—Lymphatic Leukemia. Wilson Stain. × 800. (Original Drawing.)

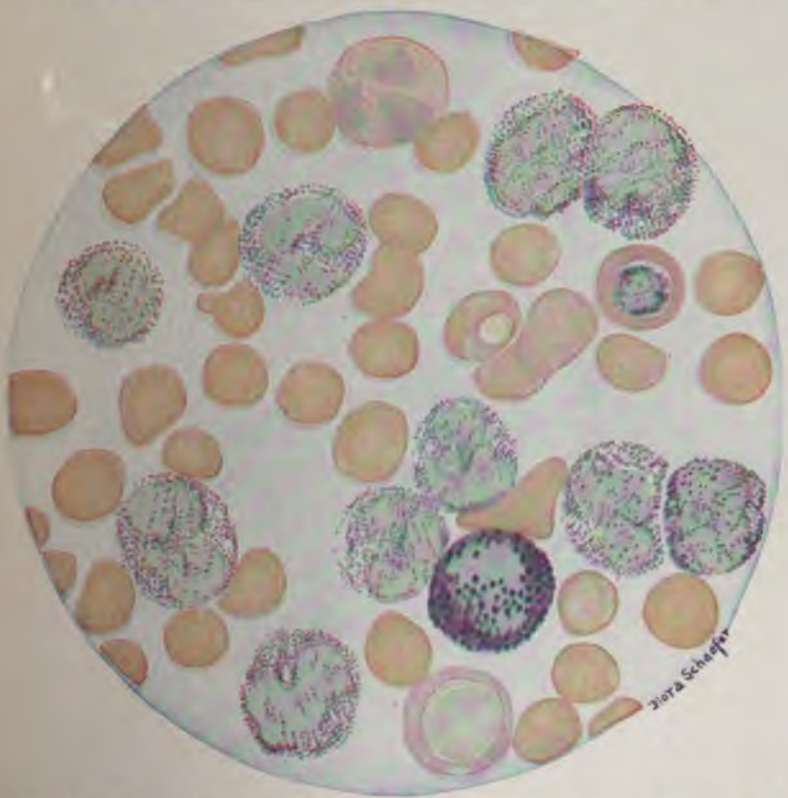


Fig. 2.—Myelogenous *Leukemia Showing Neutrophilic Myelocytes, Eosinophilic Myelocyte, Mast Cell, Nucleated Red Cell,* and a Myeloblast. Ehrlich Stain. × 800. *(Original Drawing.)*

Definition

A disease characterized by enlargement of lymph glands with progressive anemia and fatal termination

Pathology

Lymph glands enlarged, soft and elastic; later become firm and hard. Fusion does not occur, on section grayish white appearance. Microscopic proliferation of endothelial and reticular cells. Lymphoid cells and eosinophils present

INFECTIOUS DISEASES

INFECTIOUS DISEASES OF KNOWN ORIGIN

A—TUBERCULOSIS

Definition

An infectious granuloma characterized by the formation of a tubercle and caused by the tubercle bacillus

Varieties

1—Gray when fresh

2—Yellow, when fatty degeneration and caseation

Size

Single tubercle 1/12 inch in diameter, a number may unite to form a mass as large as a hazel-nut

Seat

1—Respiratory system

2—Serous membranes

3—Mucous membrane

4—Lymph glands

Time of occurrence

Childhood or early adult life, no age exempt

Histological structure

1—In center tubercle bacillus

2—Surrounded by layer of giant cells

3—Surrounded by layer of epithelioid cells

4—Surrounded by layer of leukocytes

5—Delicate reticulum

6—No new blood vessels

Secondary changes

1—Caseation

2—Fibrosis

3—Encapsulation
4—Calcification

Termination
1—Discharged or removed artificially, may heal by scar tissue
2—Quiescent
A—Encapsulation
B—Calcification
3—Death
A—Intoxication
B—Exhaustion

Avenue of entrance
1—Respiratory passage
2—Digestive tract
3—Skin
4—Inoculation

Modes of spread
1—Continuity
2—Contiguity
3—Lymphatics
4—Blood

Prognosis
Depends on
A—Previous health
B—Organs involved
C—Number of organisms
D—Social condition

B—DIPHTHERIA

Cardinal Pathology
Formation of a membrane on tonsils, larynx, pharynx, nose or conjunctiva; membrane firm and closely adherent, becomes soft and pultaceous

Microscopically
Composed of mesh work of fibrin, containing bacilli, coagulated protoplasm, desquamated epithelium

Associated Pathology
Lymphatic glands enlarged; parenchymatous changes in the viscera
Tendency to peripheral neuritis

C—CHOLERA ASIATICA

Gross
Small intestine contains rice water stool, mucosa swollen and

hyperemic. Epithelial lining desquamated, peritoneum sticky, parenchymatous changes in the viscera

D—BUBONIC PLAGUE

Lymphatic glands enlarged, tendency to suppurate; hemorrhage into the skin and serous surfaces; parenchymatous changes in the viscera

E—GLANDERS

Localized in the nose (Glanders), or beneath the skin (Farcy). Essential Pathology: granulomatous tumor, characterized by presence of lymphoid and epithelioid cells, and bacilli. Nodular masses break down, leaving ulcers

F—ANTHRAX

Definition

Infectious disease, caused by bacillus anthracis

Varieties

1—External

A—Malignant pustule

B—Malignant edema

2—Internal

A—Pulmonary

B—Intestinal

Morbid Anatomy

1—Malignant pustule

Papule becomes vesicle, surrounded by inflammatory induration; brown eschar production; involvement of lymphatics

2—Malignant edema

Begins in eyelids, great intensity may result in gangrene

3—Pulmonary and intestinal

Same changes as in pustule and edema

G—LEPROSY

Morbid Anatomy

Granulomatous, connective tissue tumors, containing Bacillus leprae; involves skin and mucous membrane; ulceration may occur, also peripheral neuritis

H—TYPHOID FEVER

I—Cardinal Pathology

Inflammation of the Peyer's patches which go through the stages of

A—Hyperplasia

Peyer's patches swollen, reddened and edematous, due

to proliferation of lymph follicles and extravasation of cellular contents of blood vessels

B—Necrosis

Due to pressure of the exudate on the surface, depriving the tissues of their nutrition

C—Ulceration

Due to coalescence of the necrotic areas; the ulcer runs longitudinally with the bowel

D—Cicatrization or healing

See general pathology of healing

II—Associated Pathology—common to all infectious diseases

(*Student is expected to follow outline on page 26*)

III—Differentiation between tubercular and typhoid ulcer of the intestine

TYPHOID	TUBERCULAR
1—Acute	1—Chronic
2—Long axis longitudinal	2—Long axis transverse
3—Floor thin, edges undermined	3—Floor thickened, studded with gray tubercles; gray tubercles around ulcer on serous coat
4—Hemorrhage and perforation occasional	4—Hemorrhage and perforation rare
5—Cause: bacillus typhosus	5—Cause: tubercle bacillus

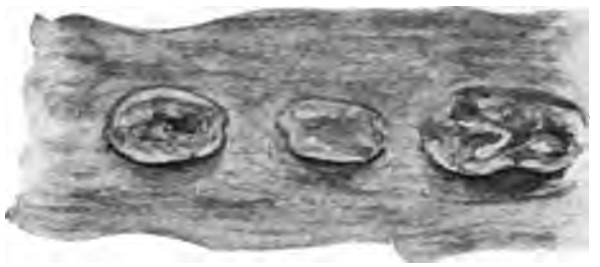


FIG. 24.—Necrosis of Peyer's Patches, Typhoid Fever

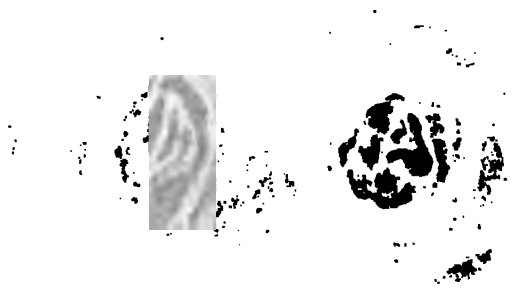


FIG. 25.—Tubercular Ulceration of the Intestine

I—ERYSIPELAS

Gross

Bright red eruption, sharp line of demarcation, heals in the center, spreads by way of periphery, vesicles may form on the surface

Microscopical

All signs of inflammation; lymphatics filled with streptococci

A—Cellular and serous infiltration occurs

B—Smaller blood vessels filled with leukocytes

C—Necrosis may occur in gangrenous erysipelas

D—Cellulitis or phlegmonous infiltration

E—Periphlebitis may occur

F—Most common seats involved

Face and scalp 90%

Leg and foot

J—SYPHILIS

Definition

Infectious disease caused by Treponema pallidum

Morbid Anatomy

1—Primary stage—chancre

Gross

Begins as papule or erosion; hard indurated base, saucer-shaped depression, slight discharge, painless lymphatic enlargement in chains which do not tend to suppurate

Microscopic

a—Diffuse infiltration of connective tissue with round cells

b—Large epithelioid cells

c—Giant cells

d—Changes in the small arteries and veins; thickening of intima, acute obliterative endo-arteritis

2—Secondary stage

A—Skin eruptions

a—Erythematous syphilid

Erythema, maculae and roseolae. General characters: polymorphous, symmetrical, raw-ham color: 6–12 weeks following infection

b—Papular syphilid

c—Pustular syphilid

d—Tubercular and gummatous

B—Mucous lesions

c—Condylomata

3—Tertiary
Gumma
Gross
Firm, elastic, yellow, or whitish nodular masses, varying in size from a tubercle to an orange, surrounded by capsule on section; mucoid, or gelatinous and vascular
Microscopic
Giant cells, round cells, nuclei, fat granules, and cholesterin; around this epithelioid cells and degenerated blood cells

INFECTIOUS DISEASES OF DOUBTFUL ETIOLOGY

A—SMALL-POX (VARIOLA)

I—Cardinal Pathology in the skin
1—Macule
Gross
On fourth day of the disease; hair line and wrist line; from pin-head to pea size
Microscopic
Dilatation of the blood vessels
2—Papule
Gross
On sixth day; hard, shot-like beneath the skin
Microscopic
Proliferation of the papillary layer of the skin
3—Vesicle
Gross
On the eighth day, becomes umbilicated vesicle, multilocular, base indurated
Microscopic
Hydropic degeneration of the papule
4—Pustule
Gross
On the tenth day vesicle filled with pus loses its umbilication
Microscopic
Filled with degenerated leukocytes; bacteria and protoplasm in solution
5—Crust
Twelfth day, due to inspissation of the pus; desquamation takes place in coarse casts or masks

II—Associated Pathology
(*Student expected to employ outline on page 26*)

B—SCARLET FEVER

I—Cardinal Pathology
Bright red eruption, looks like sand beneath the skin, most marked on flexor surfaces of joints, appears on second day; occasional petechiae in malignant form

II—Associated Pathology
Strawberry tongue, due to papillae appearing above gray coat. Pharyngitis, tonsilitis, and kidney degeneration

C—MEASLES (RUBEOLA, MORBILLI)

I—Cardinal Pathology
Maculo-papular eruption, dirty blotchy red, tend to form crescents with healthy skin between

II—Associated Pathology
1—Koplik's Spots, bluish, white specks with red areolae, opposite upper milk molars, occur in 97% of the cases
2—Predilection for inflammation of respiratory tract

D—TYPHUS

I—Cardinal Pathology
Fever plus purpuric eruption on the skin

E—ACUTE POLIOMYELITIS

I—Cardinal Pathology
Anterior horn swollen and marked by spots of blood; round cell infiltration, degeneration of ganglion cells

II—Associated Pathology
Swelling of lymphoid apparatus, inflammation of meninges, increased cerebrospinal fluid

F—HYDROPHOBIA

Accumulation of leukocytes around blood vessels and nerve cells, forming rabic tubercles of Babes. Irregular bodies in cells of cerebellum, cerebrum, and cord; probably protozoan; called Negri bodies

DISEASES AND CHANGES DUE TO PHYSICAL AGENTS

A—SUNSTROKE

Rigor mortis early, putrefaction changes with great rapidity, venous

engorgement extreme, especially in brain; left ventricle contracted, lungs congested, parenchymatous changes in viscera

B—CAISSON DISEASE (DIVER'S PALSY)

Under pressure tissues give off nitrogen gas to blood which is held under pressure; during decompression this gas is liberated and acts as emboli in the blood

C—MOUNTAIN SICKNESS

No special pathology; condition due to lack of oxygen caused by diminished atmospheric pressure

D—POSTMORTEM CHANGES IN TISSUE

I—Cadaveric lividity (hypostasis)
II—Putrefactive changes (greenish discoloration)
III—Cooling (algor mortis)
IV—Rigor Mortis
V—Adipocere
VI—Petrification

E—BURNS

I—Burns before death

Inflammation, area covered with vesicles, which may undergo suppuration. Auto-intoxication and acidosis from insufficient elimination by the skin. The visceral changes are: albuminous degeneration of liver and kidneys, focal necrosis of spleen and of bone-marrow; capillary thrombosis, interstitial hemorrhage in the kidney, ulcer of the small intestine

II—Burns after death

Inflammatory phenomena absent

F—DEATH BY DROWNING

(*See Medical Jurisprudence*)

G—DEATH BY STRANGULATION

The blood is of a dark color, owing to complete reduction of the hemoglobin. The proportion of carbonic acid is increased, and owing to its excess the blood coagulates slowly or imperfectly, hence it remains fluid or forms few and soft coagula. The cavities of the right side of the heart are distended with dark fluid blood. The left side is usually empty. The lungs are congested; also the abdominal viscera, especially the kidneys. The appearance of the brain varies; it may be anemic or more or less congested. Commonly punctate ecchymoses are visible on the conjunctiva, face, neck and chest. They are con-

sidered to be more frequent in strangulation than in asphyxia from other causes. In the subcutaneous cellular tissue, and in the fascia of the muscles above and below the hyoid bone extravasations are found. The lungs vary as regards their vascularity but on the surface it is common to find pseudomembranous patches, which are due to the rupture of some of the superficial air cells and collections of the air bubbles under the pleura. In the substance of the lungs congested patches or apoplectic extravasations are often found varying in size, but larger than those usually found in suffocation

II—SENILE CHANGES IN TISSUES OF BODY

I—Loss of weight and cessation in growth
II—Loss of stature, brittleness of the bone
III—Rigidity of the cartilages
IV—Loss of elasticity of the crystalline lens
V—Atrophy of the muscles
VI—Grayness of the hair
VII—Arteriosclerosis
VIII—Sclerosis of the viscera

INTOXICATION

A—ALCOHOLISM

Nervous system
Pachymeningitis, chronic encephalitis
Digestive system
Chronic gastritis, atrophic sclerosis of the liver, fibroid changes everywhere

B—PLUMBISM

Lead in tissues, muscles yellow, fatty and fibroid. Nervous system shows a peripheral degenerative neuritis. Encephalitis and arteriosclerosis

C—PELLAGRA

Atrophy of the walls of the intestines, fatty degeneration of the internal organs, changes in the nervous system, alterations in the cord, atrophy of the cerebrum

DISEASES OF METABOLISM

A—GOUT

Blood contains excessive uric acid and basophilic granules. The first metarso-phalangeal joint is involved with deposit of urates and a local necrosis of the cartilages; deposit thickest at the point most distant from the circulation. Ligaments, infiltrated with biurate deposits: so-called tophi. Exostosis of bone, cartilage of the ear may contain tophi

B—DIABETES MELLITUS

I—Pancreas—atrophic, hyaline degeneration of the islands of Langerhans, chronic interstitial pancreatitis
II—Kidneys—diffuse nephritis with fatty degeneration
III—Liver—enlarged and fatty
IV—Nervous system—neuritis, encephalitis
V—Blood—hyperglycemia

C—DIABETES INSIPIDUS

No constant pathology, kidneys enlarged and congested, bladder hypertrophied, dilatation of the pelvis of the kidney

D—RICKETS

I—Irregular proportion of parts
II—External members emaciated
III—Skin loose and flaccid
IV—Bulging of epiphyses
V—Line of ossification irregular and spongy, more vascular than normal
VI—Periosteum strips off more easily
VII—Liver, spleen, and glands enlarged

E—SCURVY

Severe anemia and leukocytosis. Skin ecchymotic. Hemorrhages in muscles and joints. Hemorrhages in internal organs. Gums swollen and ulcerated. Teeth loosen and fall out, hemorrhages from mucous membranes. Parenchymatous changes in the viscera

F—ARTHRITIS DEFORMANS

I—There are alterations in the cartilages of the joints; softening and ulceration or erosion which makes the surface irregular and rough
II—Hyperplasia of the cartilage-cells takes place; they undergo degeneration, and are absorbed

III—The cartilage is gradually reduced and the ends of the bone laid bare

IV—The synovial membrane and ligaments become thickened by hyperplasia

V—The articulating end of the bone is involved; absorption and proliferative changes at the periphery of the articulation in the form of exostoses or osteophytes

VI—The joint is deformed and thickened

VII—Subluxation and deformity leads to ankylosis

DISEASES OF DUCTLESS GLANDS

A—SUPRARENALS

I—Addison's disease

Definition

Disease characterized by vascular asthenia, irritability of the stomach and pigmentation of the skin

Pathology, changes in suprarenal glands

A—Fibro-caseous, changes due to tuberculosis

B—Simple atrophy

C—Chronic interstitial inflammation

D—Malignant changes

E—Blood extravasation

F—Pressure inflammation of the semilunar ganglion

B—THYROID

I—Goiter (Bronchocele, struma)

Whole gland involved; when appearance of gland is normal it is called parenchymatous goiter. When the blood vessels enlarge, called vascular goiter; may become cystic and contains blood

II—Cretinism

Congenital absence of thyroid gland

III—Exophthalmic goiter (Graves'; Basedow's; Parry's disease)

Increased proliferation, production of new spaces, absorption of colloidal substance. Increased lymphoid tissue, atrophy of cellular elements

C—SPLEEN

I—Splenomegaly with anemia (Banti's disease)

Definition

Primary disease of the spleen, characterized by enlargement, anemia, tendency to hemorrhage, secondary cirrhosis of the liver, jaundice and ascites

Pathology

Spleen enlarged, firm; capsule thickened, advanced fibr proliferation of endothelial cells, vessels dilated and atl matous

D—PITUITARY BODY

I—Acromegaly

Pathology

Change in the pituitary glands, hyperplasia, adenoma other tumors; changes in bones, enlargements of extr ties due to periosteal growths

DISEASES OF THE NERVOUS SYSTEM

A—CEREBROSPINAL MENINGITIS

I—Cardinal Pathology

Gross

Hyperemia of the membranes, brain, spinal cord, cra and spinal nerves

Microscopic

Exudation of serum and lymph most marked at the ba:

II—Associated

Parenchymatous degeneration of all the viscera

B—PARETIC DEMENTIA

Inflammation of dura mater (Pachymeningitis); of arachnoid pia mater (Leptomeningitis). Brain diminished in size, fissures increased cerebrospinal fluid, destruction of ganglion cells

C—PROGRESSIVE (CENTRAL) MUSCULAR ATROPHY

I—Neurogliar degeneration of anterior horn of spinal cord

II—Ventral roots degenerated

III—Muscles: degenerative atrophy

IV—Medullary degeneration

V—Sclerosis of anterior tracts

VI—Sclerosis of pyramidal tract

D—SCLEROSIS OF THE BRAIN

I—Miliary sclerosis

II—Diffuse sclerosis

III—Tuberculous

IV—Multiple (disseminated)

E—SYRINGOMYELIA

Definition

Gliomatous new growth about central canal of spinal cord with cavity formation

Morbid Anatomy

Cavity may run entire length of cord; oval or circular. Microscopically: a gliosis with hemorrhage and degeneration forming a cavity

F—ACUTE MYELITIS

Cord swollen, pia injected, consistency reduced, nerve fibers swollen and irregular myelinic degeneration; vascular distension, ganglion cells degenerated

G—CEREBRAL HEMORRHAGE

Rupture of lenticulo optic and lenticulo striate arteries. Extravasation of blood in brain; may be absorbed, or become cystic, or undergo suppuration or calcification. Direct degeneration of motor neurones

—EMBOLISM, THROMBOSIS (CEREBRAL SOFTENING)

Degeneration and softening of parts supplied by lenticulo-optic and lenticulo striate arteries; hemorrhagic or anemic infarcts

-NEURITIS

Nerves swollen, red, infiltrated, may be perineural or deeper (Interstitial); myelin fragmented, nerve fiber may be replaced by connective tissue, parenchymatous changes like Wallerian degeneration

-TABES DORSALIS

I——The posterior columns of the spinal cord are gray and shrunken, and show overgrowth of connective tissue in the columns of Goll, Burdach, and Lissauer; this process extends upward from the lumbosacral region

II——Posterior nerve roots degenerate and become atrophic

III—The meninges become opaque and adherent

IV—The cranial nerves may also atrophy

V——Charcot's Joint

Definition

Neuropathic arthritis

Varieties

Atrophic

Bones eroded, ligaments stretched, articulation becomes flail like

Hypertrophic

New osseous formation; feels like bag of bones; fixation of joint

K—WALLERIAN DEGENERATION

Definition

Degeneration of a nerve when it is separated from its nutritive center

Anatomy

Axis cylinder dies; medullary sheath breaks up into drops of myalin

L—SENILE DEMENTIA

General sclerosis of the cerebral arteries, with hyaline degeneration. Thinning of the cranial bones, the diploe is visible. External and internal pachymeningitis; atrophy of the cortex, especially of the frontal lobes. Hemorrhages and thrombotic softening are common. Microscopically an overgrowth of neuroglia at the expense of nerve-cells is noted

Note: (*See* sections on Medicine and Surgery for additional pathology.)

SECTION III

PHYSIOLOGY

Definition:

Physiology is the science that treats of the phenomena of normal living matter.

BLOOD

A—DEFINITION

Blood is the internal liquid medium of the body, and has the following functions

1—Food distributor
2—Waste collector
3—Heat regulator
4—Bactericidal
5—Carries internal secretions

B—PHYSICAL DESCRIPTION

I—Color,—bright red in arteries to dark blue in veins

II—Odor,—characteristic

III—Reaction,—alkaline due to sodium carbonate and sodium phosphate. Alkalinity reduced by exercise, lactation, and various diseases

IV—Specific Gravity 1.055–1.065

Obtained by Hammerschlag's method. Mix a heavy liquid like chloroform and a light liquid like benzol in such proportions that the drop of blood floats in the center; then take the specific gravity of the liquid

C—COMPOSITION—By volume

I—Solids.....40–48%
1—Erythrocytes
2—Leukocytes
3—Platelets

II—Liquids.....(Known as plasma)
1—Water 90%
2—Dissolved solids 10%
A—Proteins

a—Serum Globulin
b—Serum Albumin
c—Fibrinogen
d—Nucleo-proteid

B—Salts
a—Chlorides
b—Phosphates
c—Carbonates
d—Sulphates
e—Fluorides of Na K Ca and Mg

C—Sugar.....0.2%

D—DESCRIPTION OF CONTENTS

I—Erythrocyte (Red cell)

1—Origin
In embryo—vascular area of the mesoderm
In adult—bone marrow of flat bones, liver and spleen

2—Fate
Destroyed in liver, spleen and blood

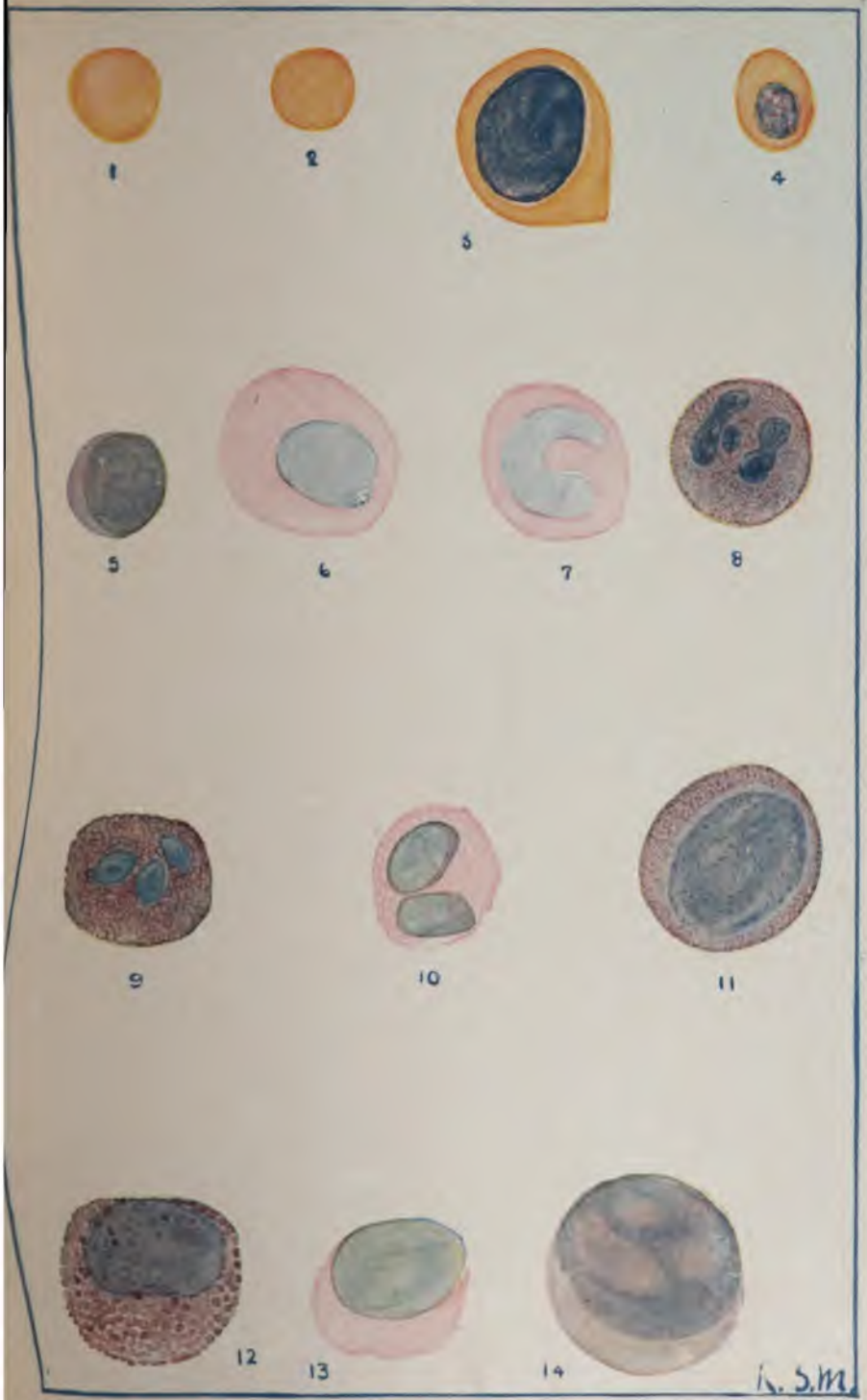
3—Size
1/3200 inch in diameter

4—Description
Bi-concave disk; no cell wall; no nucleus

5—Function
Carry oxygen to the tissues and remove carbon dioxid

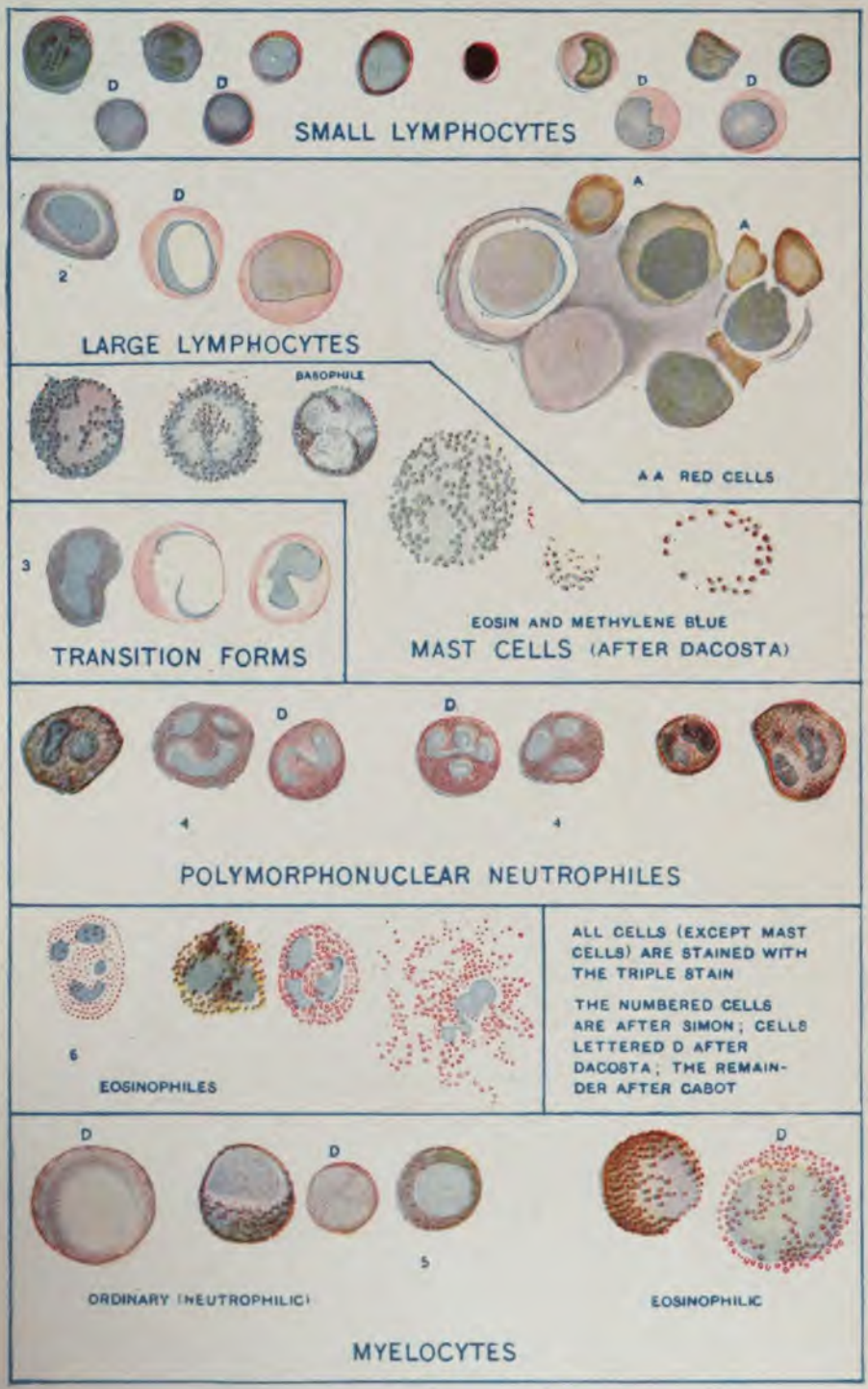
6—Composition
A—Stroma, a spongy network
B—Hemoglobin, which is 14% of the blood and is measured by a hemoglobinometer, contains 0.45% of iron, which totals about three grams of iron in the blood. Color index is the percentage of hemoglobin divided by percentage of red blood cells.
Composition
Globin, contains C H N O
Hemochromogen, unites with oxygen to form oxyhemoglobin and with CO_2 to form carbon dioxid hemoglobin which does not interfere with the oxygen-carrying power of the blood, because it unites with the globin and allows the hemochromogen to carry the oxygen. Hemoglobin unites with carbon monoxid to form carbon-monoxid hemoglobin which interferes with the oxygen-carrying power of the blood; it unites with the hemochromogen and fixes the hemoglobin

PLATE VIII



Figs. 1, 2.—Normal red corpuscles.
Fig. 3.—Megaloblast.
Fig. 4.—Normoblast.
Fig. 5.—Lymphocyte.
Fig. 6.—Large mononuclear leukocyte.
Fig. 7.—"Transitional" leukocyte.
Fig. 8.—Polynuclear neutrophilic leukocyte.
Fig. 9.—Polynuclear eosinophilic leukocyte.
Fig. 10.—Mast cell or polynuclear basophilic leukocyte.
Fig. 11.—Neutrophilic myelocyte.
Fig. 12.—Eosinophilic myelocyte.
Fig. 13.—Mast myelocyte or basophilic myelocyte.
Fig. 14.—Myeloblast.

PLATE IX



THE VARIETIES OF LEUCOCYTES

Derivatives of Hemoglobin
1—Hematoidin
2—Hemin
3—Methemoglobin
4—Hematoporphyrin

7—Number—5,000,000 per cu. mm. (4,500,000 in female)
A—Sex—more in male
B—Age—more in new born
C—Diurnal—highest in morning
D—Increased—after great loss of fluid
E—Altitude—causes an increase

II—Leukocyte (White cell)

1—Origin
Formed in the lymph glands, lymph follicles, and spleen

2—Fate
Destroyed in the blood

3—Size
1/2500 inch in diameter

4—Description
Circular disk containing nucleus; no cell wall

5—Composition
Water, nucleins, globulins, fats, salts

6—Classification
A—Nongranular
a—Small lymphocytes 25%
b—Large lymphocytes 7%
B—Granular
a—Polynuclear neutrophils..... 65%
b—Polynuclear eosinophils..... 2%
c—Polynuclear basophils.....0.5%

FIG. 26.—Illustrating the Varieties of Leucocytes

7—Number 7,000 to 10,000—increased in
A—New born
B—Digestion
C—Pregnancy
D—Lactation
E—Exercise

8—Function

A—Phagocytosis

B—Aids in coagulation of the blood

C—Carries fat to the tissues

D—Prepares proteid for the blood

5—Absorption and elimination of proteid

III—Platelets of Hayem

Small colorless irregular shaped bodies about ¼ the diameter of a red blood cell, number from 200,000 to 500,000 per cu. mm.; their function is unknown but may have something to do with the coagulation of the blood

Origin—nuclei of leukocytes or pigments of red blood cells

E—COAGULATION OF THE BLOOD

The normal blood contains

1—Prothrombin

2—Calcium salts

3—Fibrinogen

When blood is shed the white blood corpuscles furnish a substance called THROMBOKINASE, which in the presence of calcium salts transforms prothrombin into thrombin, which is the Fibrin Ferment. The thrombin acts on the fibrinogen and fibrin is formed. Fibrin makes a network and entangles the blood cells

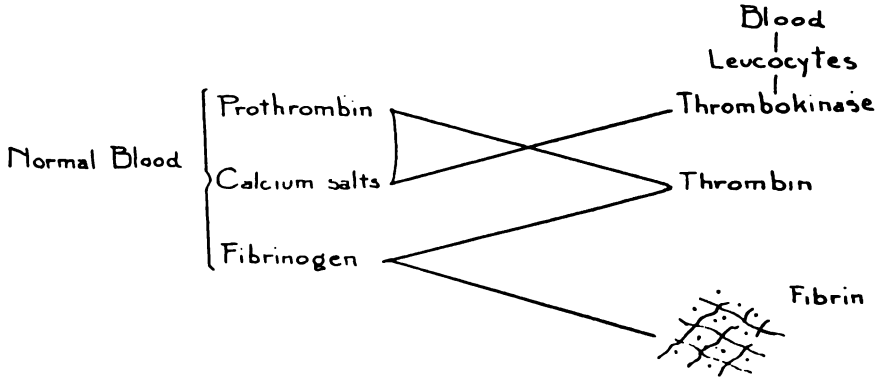


FIG. 27.—Illustrating the coagulation of the blood, the underlying basis is the conversion of a soluble proteid, fibrinogen into an insoluble fibrin, which entangles the cells and forms the clot

Why blood does not coagulate within the living vessels is a question which has not been settled. It is believed that the liver cells produce an antibody called antithrombin; this antithrombin neutralizes the fibrin enzyme or thrombin which is an essential factor in the process of coagulation

I—Conditions which retard coagulation

1—Cold

Fig. 1.—Normal red corpuscle.
Fig. 2.—Pale or anemic corpuscle.
Fig. 3.—Basophilic granules in erythrocyte.
Fig. 4.—Nuclear particle (Howell's body) in erythrocyte.
Fig. 5.—Erythrocyte containing nuclear particle and basophilic granules.
Fig. 6.—Polychromatophilic red cell containing a Cabot's ring body.
Fig. 7.—Normoblast.
Fig. 8.—Slightly polychromatophilic erythrocyte containing a nuclear particle, Cabot's ring body, and violet colored basophilic granules.
Fig. 9.—Normoblast showing an early stage of *karyorrhexis*.
Fig. 10.—*Megaloblast*, markedly polychromatophilic.
Fig. 11.—Poikilocyte, markedly polychromatophilic and exhibiting reddish basophilic granules.
Fig. 12.—Blood platelets.
Figs. 13, 14.—Small lymphocytes.
Fig. 15.—Large lymphocyte, exhibiting azurophilic granules.
Fig. 16.—Large mononuclear leukocyte with a few azurophilic granules in the cytoplasm.
Fig. 17.—"Transitional" leukocyte with fine azurophilic granules.
Fig. 18.—Polynuclear neutrophilic leukocyte.
Fig. 19.—Polynuclear eosinophilic leukocyte.
Fig. 20.—Mast cell or polynuclear basophilic leukocyte.
Fig. 21.—Neutrophilic myelocyte.

2—Addition of water, glycerin or other viscid substance
3—Contact with living tissue
4—Addition of neutral salts
5—Inflammatory states
6—Injection of ferment

II—Conditions which hasten coagulation
1—Moderate warmth
2—Rest
3—Contact with foreign matter
4—Injury to blood vessel wall

F—BLOOD IN THE BODY

1/20 of the body weight is composed of blood, distributed as follows
1—¼ in the heart, lungs and large vessels
2—¼ in the liver
3—¼ in the skeletal muscles
4—¼ in the rest of the body

Hemorrhage
1—2–3% of body may be lost without danger
2—Regeneration of blood after hemorrhage
A—Absorption from tissue or ingested food
B—Cellular elements derived from lymphatic glands or bone marrow; 7–24 days for red blood cells to reform

G—GASES OF THE BLOOD

	O	CO_2	N
I—Arterial	20 volumes	39 volumes	1–2 volumes
II—Venous	8–12 volumes	46 volumes	1–2 volumes

H—SPECTRUM OF BLOOD

I—Oxygen hemoglobin
1—Alpha near D line in yellow
2—Beta narrower and more intense than alpha to right hand of green

II—Reduced hemoglobin
1—Gives one broad absorption band between alpha and beta

I—HEMOLYSIS

Definition

The act of discharging the hemoglobin from the corpuscles so that it becomes dissolved in the plasma is designated as hemolysis, and substances that cause this action are spoken of as hemolytic agent. A number of such agents are known; but although the result of their action is the same, so far as the hemoglobin is concerned, the way in which they bring about this result must vary

greatly. Some of the known methods of producing hemolysis, or rendering the blood "laky," are as follows

A—By the addition of water to the blood or by diminishing in any way the concentration or osmotic pressure of the plasma

B—By adding ether or chloroform

C—By the addition of soaps or of the higher fatty acids, especially the unsaturated acids

D—By adding bile or solutions of the bile-salts

E—By adding the serum from the blood of certain animals

F—By the addition of an excess of alkali

G—By various toxins found in snake venom or in the products of bacterial activity (natural hemolysins), or by similar organic substances produced within the body by the process of immunizing. Some of these hemolytic agents, such as ether, bile-salts, and soaps, probably effect their action by their power of uniting with the lipoid elements (lecithin, cholesterin) in the stroma of the corpuscles. The framework of the corpuscles is thus altered so that the hemoglobin is set free

LYMPH

A—DEFINITION

Internal liquid medium of the body, contained in lymph spaces and vessels

B—FUNCTION

I—Conveys food and products of digestion to the tissues

II—Removes effete matter from the tissues

III—Relieves the blood from an excess of food

IV—Powerful solvent

V—Lubricant

VI—Takes part in healing of wounds

VII—Special function of equilibrium (endolymph)

C—PHYSICAL DESCRIPTION

Clear, colorless, albuminous liquid, alkaline in reaction; specific gravity about 1.014

D—COMPOSITION

Solids

8,000 lymphocytes per cu. mm.

Liquids (Lymph plasma)

Fibrinogen, serum globulin, serum albumen, water, and salts

E—ORIGIN—Theories

I—Formed from the blood plasma by a process of filtration, diffusion, and osmosis (Ludwig's theory)

II—Vital and selective activity of the endothelial cells that line the lymphatics

III—Heidenhain's theory of lymphagogues

F—FORCES—Concerned in the circulation of the lymph

I—Presence of blood in the blood vessels

II—Thoracic aspiration

III—Muscular contraction of the voluntary muscles

IV—Contraction of the intestines

V—Action of valves in lacteals and lymphatic channels

VI—Continuous production of lymph

G—VELOCITY OF FLOW

4 mm. per second. Amount discharged by thoracic duct is 60 c.c. per kg. of body weight per day

H—FUNCTION OF GLANDS AND VESSELS

I—Protective to serous surfaces, bursae, tendon sheaths

II—Absorption of digested food

III—Formation of blood cells

IV—Destruction of injurious matter

I—*ANATOMICAL BASIS*

Lymphatic system made up of a

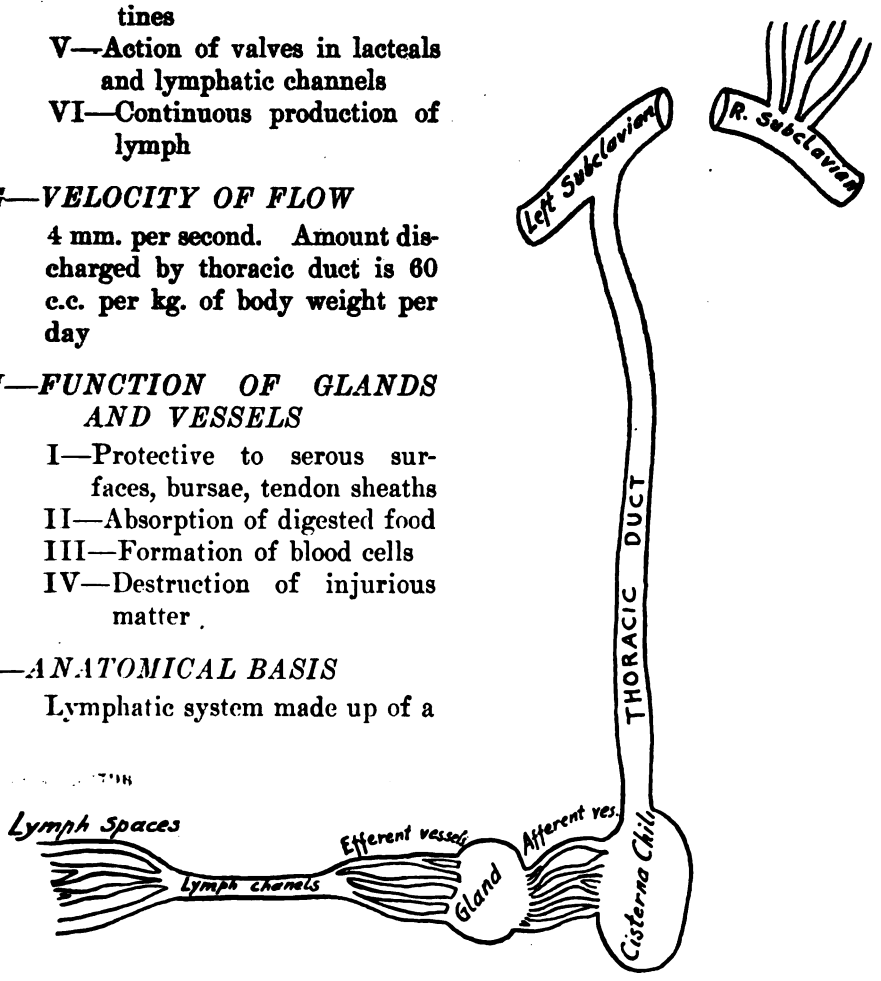


FIG. 28.—Scheme of the Lymphatic System

system of lymph spaces which unite to form lymphatic vessels; passes to gland as afferent vessels, leave the gland as efferent; all empty into the cisterna chyli; this empties into the thoracic duct which in turn empties into the left subclavian at its junction with the internal jugular, draining all the body except the right upper quadrant. The latter is drained by the lymphatic duct, which empties into the right subclavian at its junction with the internal jugular

DUCTLESS GLANDS

A—DEFINITION

A gland which, by discharging its secretion into the blood directly, needs no duct and has none

B—THE DUCTLESS GLANDS

I—Pineal
II—Pituitary
III—Thyroid
IV—Parathyroids
V—Thymus
VI—Carotid
VII—Spleen
VIII—Suprarenal
IX—Coccygeal

C—FUNCTIONS

Of all ductless glands we may assert
1—Function unknown
2—Regulate metabolism
3—Detoxifiers

I—Pineal
1—Regulates metabolism
2—Detoxifier

II—Pituitary body (Hypophysis cerebri)
1—As in all ductless glands
2—Regulates growth of bones. A lesion may cause acromegaly

III—Thyroid gland
1—Internal secretion rich in iodin
2—Neutralizes or destroys toxic bodies
3—Protection to the circulation of the brain
4—Regulates body fat
5—Removal causes myxedema

IV—Parathyroids
1—Control muscle tone, therefore
2—Lesion causes state of contraction known as tetany
V—Thymus
1—It is a blood forming organ
2—It has influence on growth and nutrition
3—In hibernating animals it is supposed to store up materials which can be utilized during the period of inactivity
VI—Carotid
Function common to all ductless glands
A—Unknown
B—Regulates metabolism
VII—Spleen
1—It is a source of production of the red blood corpuscles during fetal life
2—It is a source of production of the white blood corpuscles
3—It is a place where the red blood corpuscles are destroyed
4—Uric acid is produced in the spleen
5—An enzyme is produced in the spleen and is carried by the blood to the pancreas where it converts trypsinogen into trypsin.
VIII—Suprarenals
1—Inhibits excessive pigment formation
2—Destroys toxins in the body
3—Contraction of the blood vessels, and therefore
4—Increases the blood pressure
5—Removal causes Addison's disease
IX—Coccygeal
Function common to all ductless glands

D—MISCELLANEOUS

I—Secretion
Definition
Any product of a gland which is of further use to the body
Examples of structures furnishing secretions
A—Serous membranes
B—Synovial membranes
C—Mucous membranes
D—Glands, mouth and stomach
E—Mammary glands
F—Lacrymal glands
G—Kidneys
H—The skin

I—Testes

II—Classification

1—Internal—thrown directly into blood stream

2—External—thrown upon a free surface

III—Excretions—definition

Product of a gland which is not of further use to the body

Examples of glands furnishing excretions

A—Alveolae of lungs

B—Kidneys

C—Intestines

D—Glands of skin

IV—Histology of a gland

1—Composed of a fundus and a duct. During rest, the cells of the acini become distended with the product of the gland, and the nucleus is crowded to the periphery. After active secretion the gland is shrunken and the protoplasm and the nuclei are more distinct. The blood supply is increased during activity, with liberation of energy

2—Varieties of glands

A—Simple glands—duct undivided

a—Simple tubular—undilated at end

Examples:

A—Lieberkuhn's follicles

B—Sweat glands

C—Many of the gastric glands.

b—Simple acinous (alveolar or saccular)—dilated at end

Example

A—Some sebaceous glands (rare)

B—Compound glands—duct divided

a—Compound tubular—branched elongated tubes, no acini.

Example

A—Most gastric glands

b—Compound acinous or alveolar (racemose glands)—branched duct with saccular acini on terminal branches

Examples

A—Salivary

B—Sebaceous

C—Meibomian

D—Mucous glands of the mouth

E—Mucous glands of the tongue

F—Mucous glands of the palate

G—Mucous glands of the pharynx
H—Of the nose
I—Of the esophagus
J—Of the respiratory tubes

c—Acino-tubular: branches, duct, with elongated narrow acini on terminal branches

Example:

A—Brunner's glands

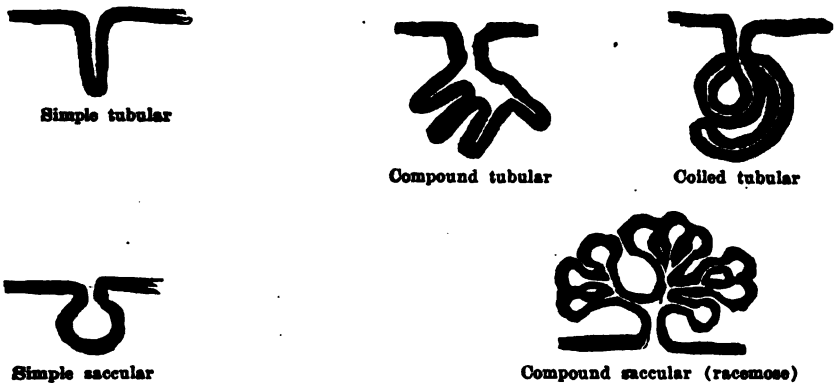


FIG. 29.—Types of Glands

V—Varieties of membranes

A—Mucous membrane—a secreting surface covered with epithelial cells. All cavities or spaces exposed to air are covered with epithelium

B—Serous membranes—all surfaces not in contact with the external air. These are lined by endothelium and form a part of the lymphatic system

C—Synovial membranes are modified serous membranes that form the lining of the synovial capsules; they secrete synovial fluid for lubrication

KIDNEY

A—*FUNCTION*

I—To secrete (or excrete) urine

1—External secretion—urine

Purpose: to regulate percentage composition of the blood, giving off

a—All abnormal constituents

b—Any excess of normal ingredients

II—The production of an internal secretion

2—Internal secretion

A—Regulates metabolism

B—Detoxifier
C—Interference with secretion may cause uremia

B—PHYSICAL DESCRIPTION—Urine

I—Amount: 1200–1500 cc. per diem
II—Acid in reaction
III—Amber in color
IV—Specific gravity 1.015–1.025

C—COMPOSITION—Urine

I—Water—1200 cc.
II—Solids

1—Urea	30 gm.
2—Salts	26 gm.
3—Pigments	10 gm.
4—Creatin, 5—Hippuric acid, 6—Uric acid	4 gm.
	70 gm.

D—THE MECHANISM OF THE SECRETION OF URINE BY THE KIDNEYS

I—By filtration, much, if not all, of the fluid is eliminated, and also inorganic salts. This depends upon blood pressure, and takes place in the glomeruli
II—By cell activity and also by selection, in the cells of the convoluted tubules, the urea and the principal solids are eliminated

E—MECHANISM

I—Amount of urine is dependent on blood pressure; there are no direct secretory nerves; they may act indirectly by influencing the blood supply

F—FLOW OF URINE INCREASED BY

I—Increasing rate and force of heart action, whereby the general blood pressure is raised
II—Constriction of the blood vessels in general, but not of those of kidney
III—Causing blood vessels in kidney to dilate without dilation in other organs

G—FLOW DIMINISHED BY ABOVE FACTORS ACTING IN REVERSE MANNER

INTEGUMENT

A—FUNCTIONS

I—Protective
II—Cosmetic
III—Sensory
1—Touch
2—Pain
3—Heat
4—Cold
IV—Excretory
V—Absorptive
VI—Regulates body temperature
VII—Slightly respiratory

B—GLANDS OF SKIN

I—Sudoriferous—secrete (or excrete) sweat under vascular and nervous control
1—Composition of sweat
Water, fat, solids, volatile fats
2—Uses of perspiration
A—Excretion of effete matter
B—Heat regulation by evaporation
C—Keeps skin moist
3—The secretion of sweat is chiefly under nervous control. Slightly under vascular control. The relation of the secretion of perspiration to the temperature of the body and the amount formed is under the control of the nervous system. An increased supply of blood to the skin acts only indirectly in increasing the secretion, which is under the direct control of special secretory nerves. This can be shown by the stimulation of any cutaneous nerve
4—Increased sweat due to
A—Elevation in outside temperature
B—Ingestion of hot water
C—Muscular activity
D—Elevation of body temperature
E—Drugs such as pilocarpin
5—Amount: 500–2000 cc. per day:—sensible (visible), insensible (invisible sweat)

II—Sebaceous-secrete sebum
1—Varieties of sebum
A—Vernix caseosa
B—Preputial smegma
C—Cerumen
D—Secretion of meibomian glands
2—Composition
Fats, soaps, proteins, salts, water, epithelial cell cholester=
3—Function
A—Keeps epidermis soft and moist
B—Makes hair pliable
C—Prevents maceration
D—Prevents excessive desiccation

CIRCULATION

A—DEFINITION

Movement of the blood in a certain given direction. Beginning at the left ventricle of the heart, the blood flows through the left semilunar valve into the aorta, from which branches are distributed to every part of the body, through the capillaries to the veins, from the veins to the venae cavae, thence to the right auricle of the heart. From the right auricle, through the tricuspid valve to the right ventricle, thence through the right semilunar valve to the pulmonary artery to the lungs, from the capillaries in the lungs to the pulmonary veins, thence to the left auricle and through the mitral valve to the left ventricle, to begin the circuit again

B—FORCES GOVERNING THE CIRCULATION

I—Contraction of the heart
II—Elasticity of arteries
III—Resistance of capillaries
IV—Negative pressure in veins

C—CARDIAC CYCLE

The two auricles contract, increasing the pressure of the blood in the auricles, opening up the auriculo-ventricular valves, and sending the blood into the ventricles. The ventricles contract, increasing the pressure, closing the auriculo-ventricular valves, which are prevented from being forced into auricle by the chorda tendinae. This increased pressure opens the aortic and pulmonic valves, through which blood is sent into the arteries

The contraction is called the SYSTOLE

The dilatation is called the DIASTOLE

The average pulse rate is 72 per minute, 18 respirations per minute

Time

Auricular systole, 0.1 sec.

Auricular diastole, 0.7 sec.

Ventricular systole, 0.3 sec.

Ventricular diastole, 0.5 sec.

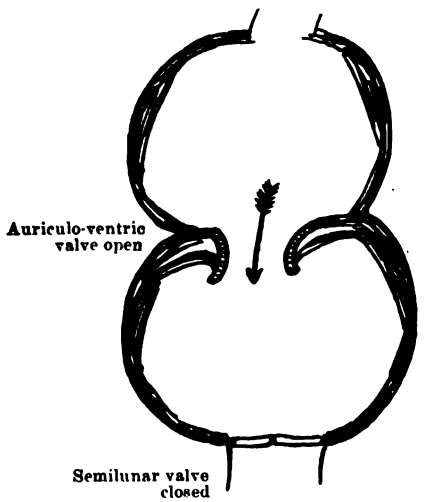


FIG. 30.—Scheme of Diastole (Blood from Auricle to Ventricle)

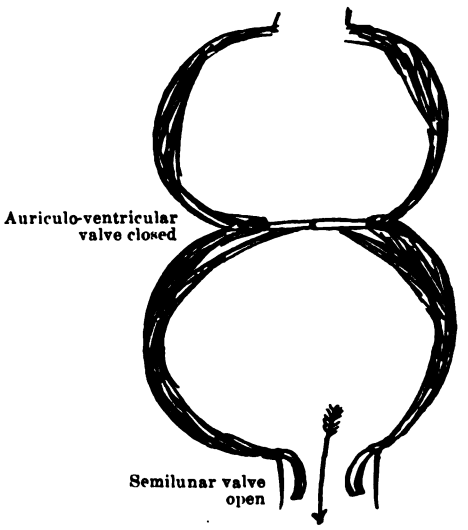


FIG. 30a.—Scheme of Systole (Blood from Ventricle to Vessels)

D—FUNCTIONS OF AURICLE

I—Force blood into ventricle

II—Reservoir for blood from the veins

III—Negative pressure in diastole increases venous flow

E—NORMAL HEART SOUNDS

I—The first sound is duller, longer and lower in pitch than the second sound, which is clearer and shorter, snapping in quality and higher in pitch. The first sound is separated from the second sound by a short interval, and the second sound from the first sound by a longer interval. The heart sounds are simulated by lub-dup——lub-dup

Causes of first sound

A—Impact of heart against chest wall

B—Contraction of ventricular muscle

C—Vibration of closure of auriculo-ventricular valves

Cause of second sound
Closure of the semilunar valves

F—SYSTOLIC OUTPUT—Pulse volume

I—Blood discharged from ventricle: 70–100 cc.

G—ENDOCARDIAC PRESSURE

Right auricle 20 mm. of mercury
Left auricle 50 mm. of mercury
Ventricles 150 mm. of mercury

H—WORK OF HEART

Heart beats 72 times per minute, left ventricle pressure 150 mm. of mercury. Right ventricle pressure is 60 mm. of mercury, rate of flow in aorta ½ meter per second; pulse volume 90 cc. Heart works 26,000 kilogram meters per diem

I—THE CAUSE OF THE APEX BEAT

I—Impact of apex against chest wall
II—Change in shape of the cardiac cone
III—Change of position

J—CARDIOGRAM—Definition

Graphic record of apex beat

K—NERVOUS MECHANISM OF THE HEART—Two Theories

I—Myogenic—automaticity of heart dependent upon peculiarity of heart muscle.
Proofs
A—Embryo's heart beats before nerves are developed
B—Certain hearts in lower animals contain no ganglion
C—Heart of animals dead for several hours can be revived

II—Neurogenic
1—The intrinsic mechanism consists of ganglia in the heart wall
2—The extrinsic consists of cardio-inhibitory and cardio-accelerator fibers. The cardio-inhibitory conveyed by the pneumogastric, which is the great cardio-inhibitory nerve
The cardio-accelerator conveyed by sympathetic

L—FUNCTIONS OF PERICARDIUM

I—Prevents heart from too great dilatation
II—Tends to prevent rupture of heart
III—Lubrication

M—FUNCTIONS OF HEART MUSCLE

I—Stimulus production

Most active at sinus venosus. The impulse originates at the remnant of primitive fibers at the superior vena cava called the sino-auricular-node, causing sinus rhythm

Refractory period

The period in which the heart fails to respond to stimulus

Nodal rhythm

Form of irregularity in which ventricular and auricular contractions are synchronous

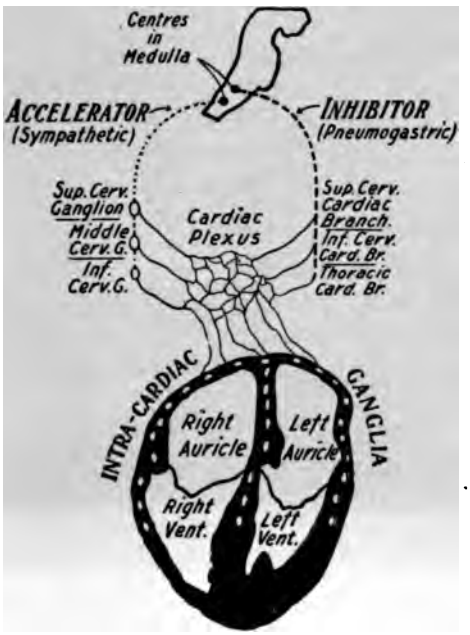


FIG. 31.—Diagram Showing the Nervous Mechanism of the Heart. Section of heart after Gegenbauer

II—Excitability

Heart muscle always gives maximum contraction; "all or nothing"

III—Conductivity

Most marked in Bundle of His, which transmits impulse from auricle to ventricle

IV—Contractility

V—Tonicity

N—*CORONARY CIRCULATION*

During contraction of the heart, the coronary vessels are constricted

During diastole they relax, favoring circulation

O—*SALTS AFFECTING THE ACTION OF HEART*

Immersed in a solution of NaCl 0.7 per cent. an isolated frog's heart

will retain its rhythmicality for some time but it ultimately passes into a condition of diastolic relaxation. It is precisely the same with KCl, and if a solution of the same strength as that of NaCl is used, the arrest occurs much earlier. The K ions and Na ions act similarly; that is, they ultimately produce a condition of diastolic relaxation; moreover K ions are more efficacious than those of Na, but with Ca ions it is different. A beating heart, if immersed in an isotonic solution of $CaCl_2$ ceases beating, in a condition of systole (calcium rigor). If, however, a solution of NaCl is added, the heart beat recurs and the strength of the contractions is increased.

ARTERIES

A—DEFINITION

Series of tubes carrying arterial blood from heart to tissues

B—CAUSE OF CIRCULATION

In arteries—

1—The elasticity and tone of the arteries
2—The force and frequency of the cardiac contractions
3—The resistance in the capillaries
4—Negative pressure in veins

C—THE PULSE

The pulse is a wave of expansion which travels along the arteries and is due to the discharge from the left ventricle of a volume of blood during systole, into the already full arterial system. It is maintained by the force of the heart, controlling influence of the nervous mechanism, and elasticity of the arteries. 130 per minute in infancy; 80–90 in youth, 70–80 in adult life, 72 average. In estimating the condition of the pulse, the following factors must be noted

1—Its frequency; this gives the rate of the heart beat
2—Its compressibility; this denotes the force with which the heart is beating
3—Its tension; this denotes the peripheral resistance and also the state of the arterial walls
4—Its regularity (or irregularities) in force or rhythm

Sphygmograph

An instrument for graphically recording the pulse wave. It consists of a spring fastened over the radial artery by means of a system of levers. The movements of the artery are transmitted to a wrist lever provided with a delicate point which records the movements of the pulse on a smoked surface.

The ascending limb is called the anacrotic limb. The apex

is called the percussion wave. The descending limb is called the katacrotic limb; upon this are registered an elevation called the predicrotic wave, a notch called the dicrotic notch, and a wave called the dicrotic wave. The remaining elevations are called elasticity elevations. The sphygmic or pulse period is the time in which the semilunar valves are open.

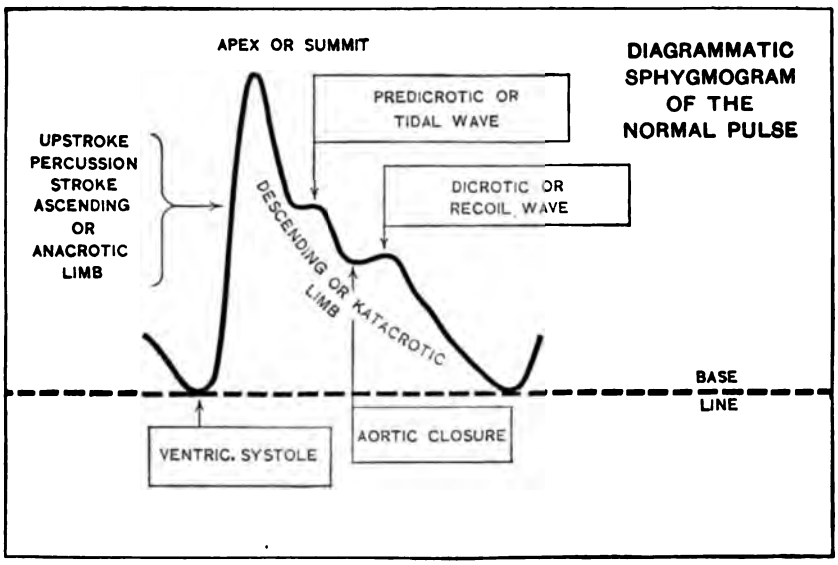


FIG. 32.—Diagrammatic Sphygmogram of the Normal Pulse

D—BLOOD PRESSURE

Systolic pressure 120–150 mm. mercury. Diastolic pressure 90–120 mm. of mercury

1—Maintained by
- A—Contraction of the heart
- B—Peripheral resistance
- C—Elasticity of arteries

2—May be raised by
- A—Heart beating more quickly
- B—Heart beating more powerfully
- C—Contraction of the arterioles

3—May be lowered by
- A—Heart beating more slowly
- B—Heart beating more feebly
- C—Dilatation of the arterioles
- D—Deficient supply of blood to the left ventricle.

E—VELOCITY OF BLOOD IN ARTERIES

12 inches per second

F—THE VASOMOTOR NERVOUS SYSTEM CONSISTS OF

I—A vasomotor center in the bulb

II—Of some subsidiary centers in the spinal cord

III—Of vasomotor nerves which are of two kinds

1—Those causing constriction of the vessels and so-called vaso-constrictor nerves

Stimulation of vaso-constrictor center (in floor of fourth ventricle) causes

A—Increase in arterial pressure

B—Lessened flow of blood

C—Decrease in venous pressure

D—Change in color of organ or tissue

E—Diminution in volume of organ obtained by plethysmograph

F—Decrease in temperature

2—Those causing dilatation of the vessels are so-called vaso-dilator nerves. These nerves supply the muscle tissue in the walls of the blood-vessels and regulate their caliber, thus influencing the quantity of blood supplied to a part; secretion and heat production. They are concerned, too, in the control of the heart beat. Center is in the medulla in the floor of the fourth ventricle, near the calamus scriptorius

VEINS

A—DEFINITION

Series of vessels conveying blood from tissues to heart

B—FORCES GOVERNING CIRCULATION

In the veins, circulation is regulated by

1—Action of the heart

2—Aspiration of the thorax

3—Contraction of the body muscles

4—Slightly by the valves in the veins

5—Vis-a-tergo

C—PHLEBOGRAM—Definition

Graphic tracing of a vein, the jugular being usually used for this purpose. Three waves, and two depressions called negative phases. First wave is caused by the contraction of the right auricle. Second wave is caused by the ventricular systole. The interval between the two waves is one-fifth of a second, and indicates the time between the auricular and ventricular systoles. The third wave may be caused by

1—Auriculo-ventricular septal movement
2—Bulging of the tricuspid leaflet
3—Falling of the apex away from the chest wall

The first depression marks the systole of the ventricle when the auricle is in diastole.

The second depression indicates emptying of veins into auricle.

D—VELOCITY OF BLOOD IN THE VEINS

7 inches per second.

CAPILLARIES

A—DEFINITION

Connecting link between arteries and veins

B—FORCES

In the capillaries circulation is regulated by

1—The action of the heart
2—The action of the arteries

C—VELOCITY

I—2 inches per minute, it takes 23 seconds for a drop of blood to make the complete circuit of the body

MOTOR APPARATUS—MUSCLES

A—VARIETIES

I—Striated—Voluntary—Skeletal

Covered by connective tissue sheath, called epimysium, fasiculi

surrounded by perimysium, fibers held together by endomysi
Fiber cylindrical, surrounded by sarcolemma; several nuc
cross and longitudinal striations. (*See* Section on Histolog

II—Nonstriated—Smooth—Involuntary

Small unicellular spindle-shaped fibers, not surrounded by
colemma. No transverse striation. Rod-shaped; nucleus
the fibers. Unstriped muscle fibers are slower in response
stimuli

III—Cardiac Muscle—Striated and Involuntary

Quadrilateral fiber, nucleus in center, connected to fellow
branches

B—COMPOSITION

Water	75%
Protein	20%
Fat	2%
Sugar	2%
Salt	1%
	100%

C—CHANGES IN MUSCLE DURING CONTRACTION

I—Mechanical

1—Becomes shorter and thicker; volume remains same. Th
muscle is thus more extensible and less elastic. Singl
muscular contraction called a *twitch*. When several stimul
are sent into a muscle so that it has no time for relaxatio
the twitches fuse and the muscles go into a tonic state calle
tetanus. All voluntary contractions are tetanic

II—Chemical

1—Increased oxygen consumption
2—Increased CO_2 production
3—Consumption of glycogen
4—Production of lactic acid and fatigue bodies
5—Muscle becomes acid in reaction

III—Thermic

Heat is produced. In the most favorable cases, 35–40% o
energy brought to muscle by food is converted into mechanica
energy; remainder is given off as heat

IV—Electrical

Electrical reaction becomes relatively negative. This chang
in irritability is called ELECTROTONUS. Diminished irritability

at the anode is called ANELECTROTONUS. At the negative pole it is called CATELECTROTONUS.

A—On closing the current, stimulation occurs at the cathode at the moment when catelectrotonus develops

B—On opening the current, stimulation takes place at the anode when anelectrotonus develops

D—FATIGUE

First effect of stimulation is increased irritability. Muscle responds to greater extent with same stimulus; called *staircase contraction.* Later muscle fails to respond; called fatigue

Cause

1—Consumption of potential energy

2—Accumulation of waste products

E—TRAINING

Increases ability of muscle to perform work

1—All extra movement eliminated

2—Antagonistic tension of muscle corrected

3—Production of anti-fatigue bodies

F—CONTRACTILITY

Power of protoplasm to change its shape in response to a stimulus; i.e., to change in environment

G—STIMULI AND THEIR MECHANISM OF ACTION

I—Stimuli producing contraction

1—Normal voluntary

2—Chemical

3—Thermic

4—Mechanical

5—Electric

II—Mechanism—Transmitted as follows:

1—Rolandic area

2—Corona radiata

3—Internal capsule

4—Crus cerebri

5—Pons

6—Medulla

7—Crossed and direct pyramidal tract

8—To motor cells of anterior horn
9—Carried out by cranial or spinal nerve

H—SUMMATION

If the muscles are stimulated before the effect of first stimulation is worn off, the second curve produced is higher than the first; called summation of contraction

I—LEVERS OF THE BODY

I—First order
Fulcrum between weight or resistance and power of moving force, *e. g.*, skull on atlas
II—Second order
Weight between fulcrum and power, *e. g.*, depression of lower jaw
III—Third order
Power between fulcrum and weight, *e. g.*, flexion of forearm

J—RIGOR MORTIS

Rigor Mortis is the postmortem rigidity of the muscle due to the coagulation of myosinogen in the muscle substance, with the production of heat and lactic acid. Begins in the muscle of the eye, passing to the jaw and neck, then to the chest, arms, abdomen, and lower extremities. The onset of rigidity is always preceded by a disappearance of nervous activity

ANIMAL HEAT

A—WARM BLOODED ANIMALS—Homiothermic
Animals whose body temperature is constant

B—COLD BLOODED ANIMALS—Poikilothermic
Animals whose temperature is that of the environment

C—NORMAL BODY TEMPERATURE

(98.6 F.) varies in different localities of—coldest in the skin, warmest in the liver.

The following conditions affect body temperature

1—Muscle work
2—Sleep, a fall of .2 to .8 degree
3—Daily variations
Maximum, 5 to 9 P. M.
Minimum, 2 to 5 A. M.
4—Age
5—External temperature
6—Digestion
7—Drugs

D—THERMOTACTIC CENTER—The center which regulates heat

Situated in the medulla
Made up of two divisions
1—Thermogenetic (producing heat)
Bodily heat is produced by
a—Oxidation of food
b—Muscular activity
c—Glandular activity
d—Friction of blood in blood vessels
e—Voluntary addition of heat, ingestion of hot foods, and warm applications.
2—Thermolytic (eliminating heat). Factors:
A—Vascular dilatation, radiation, and conduction..73 %
B—Sweating 14.5%
C—Excretions
a—Urine 1.8%
b—Lung 8.7%
D—Voluntary addition of cold ..... 2 %

E—THE POSTMORTEM RISE IN TEMPERATURE

Due to
1—Coagulation of the blood and myosin
2—Rigor Mortis and persistence of metabolic activity
3—Growth of hair
4—Diminished radiation and cessation of circulation

RESPIRATION

A—DEFINITION

Exchange of gases between organism and its surroundings whereby the organism is supplied with oxygen and carbon dioxid is eliminated

B—CLASSIFICATION

I—External respiration consists in the interchange between the gases of the outer air and those of the blood, lungs and skin

II—Internal respiration is the exchange of gases between the capillaries and the tissues of the body

C—PULMONARY MECHANISM

Alternate contraction and dilatation of the thoracic cage. The dilatation is called inspiration, the contraction is called expiration. The lungs lie passive in the thoracic cage and, being elastic, follow all the movements of the chest wall. Time relation of inspiration to expiration: five–six. Enlargement or inspiration is due to the fact that

1—Diaphragm descends and is withdrawn from the chest wall, ribs are elevated and rotated outward. This causes a negative pressure in thorax and air rushes in

Contraction of chest cavity, known as expiration, is due to

1—Relaxation of the muscle
2—Elasticity of the lung
3—Weight of the chest
4—Tension of the abdominal muscles

D—TYPES OF RESPIRATION

I—Diaphragmatic (abdominal)
II—Costal (thoracic)

E—DEFINITION

I—Tidal air—ordinary flow of air during respiration 500 cc.

II—Complimental air—amount of air which may be inspired after tidal inspiration. It is equal to 1500 cubic centimeters

III—Supplemental air—the amount of air which can be expired after tidal expiration. Equal to 1500 cc.

IV—Respiratory capacity, or Vital capacity—the volume of air which can be expired from lung after a forced inspiration: 3500 cc.

V—Residual air—air which remains in the lungs after forced expiration. Equal to 1500 cc..

F—RESPIRATORY SOUNDS

I—Bronchial or tubular over trachea and bronchi
II—Vesicular, over lung

G—CHEMISTRY

Comparison	Inspired air	Expired air
Oxygen	21%	16.6%
Nitrogen	79%	79 %

Comparison	Inspired air	Ex
Carbon Dioxid	0.04%	
Other gases	Rare	Often
Watery vapor	Variable	Satur
Temperature	Variable	That
Volume	Varies	Dimir
Bacteria	Always present	None
Dust	Always present	None

MECHANISM

I—Two theories

1—Vital: lung absorbs oxygen like a gland and gives

2—Physical: process of diffusion of gases. The ox
various under-mentioned media has the following part
centage pressures of an atmosphere

Atmospheric air	20.96%
Alveolar air	18.00%
Arterial blood plasma	14.00%
Tissues of the body	0.00%

What then takes place is this—The oxygen (being fluid) flows from the place of high pressure to the place of low pressure, and hence diffuses down from the inspired atmospheric air into the alveoli. From the alveoli it now passes through the thin endothelial lining of the alveolus, and the thin endothelial lining of the capillary into the blood plasma. It continues to accumulate in the blood plasma until it has a partial percentage pressure of 14 per cent. of an atmosphere, when it begins to combine with hemoglobin in the red-blood corpuscles

This causes the partial percentage pressure of the oxygen in the blood plasma to fall below 14 per cent. of an atmosphere. More oxygen now passes into the blood plasma, raising the partial percentage pressure once more to 14 per cent. and then more oxyhemoglobin is formed. Finally in this way nearly all of the hemoglobin is converted into oxyhemoglobin. The oxygen now passes from the blood plasma (the place of high pressure) to the tissues (the place of low pressure). In this way its partial percentage pressure in the blood plasma becomes less than 14 per cent. of an atmosphere, and therefore at once the oxyhemoglobin breaks up into oxygen and hemoglobin. This oxygen passing into the blood plasma, raises its partial percentage pressure once more to 14 per cent. of an atmosphere (the normal for the blood plasma), and then oxygen begins once more to pass to the tissues from the blood plasma and oxyhemoglobin to be broken down into oxygen and hemoglobin

I—THE MUCOUS MEMBRANE OF THE RESPIRATORY TRACT

I—Arrests dust particles
II—Ciliated epithelium prevents accumulation of dust and mucus
III—The squamous cells lining the air vesicles play a part in the interchange of gases
IV—Warms air
V—Moistens air

J—INTERNAL RESPIRATION—Interchange of gases in the tissues

Arterial blood
0–20 Volumes, CO_2–40 volumes, N 1–2 volumes
Venous
0–16 Volumes, CO_2–50 volumes, N 1–2 volumes
Exchange by diffusion of gases

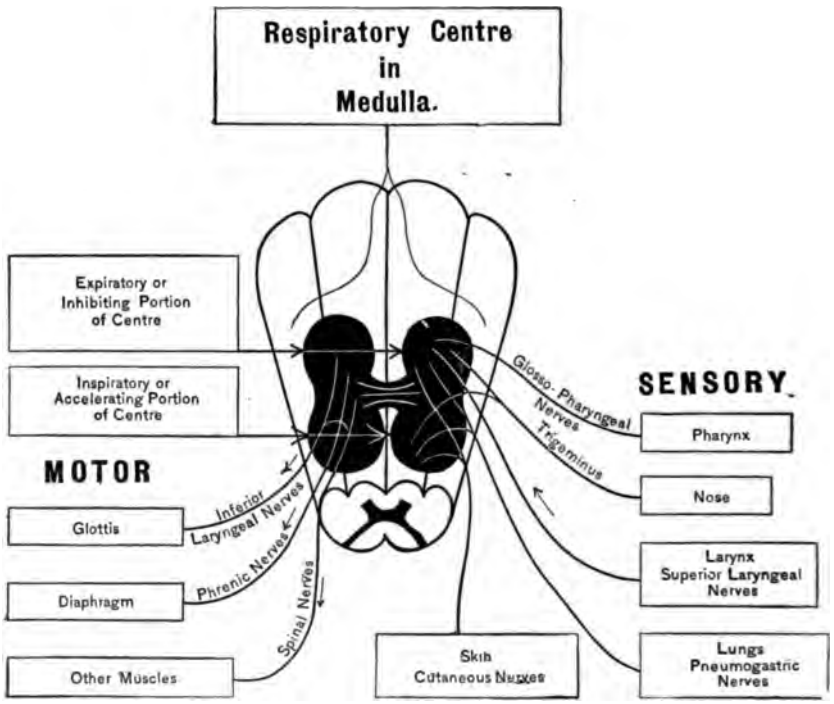


FIG. 33.—Diagram of the Respiratory Center

K—THE RESPIRATORY CENTER

Situated in medulla between 9–10 cranial nerves is in reality made up of two centers, one for each side; so that, although anatomically connected and ordinarily acting together yet if one center is broken down, while the respiratory movements on that side cease, those on the other side continue. Besides this double character of the center,

each half is made up of an inspiratory and an expiratory center. The respiratory center is both an automatic and a reflex center; *i. e.* it sends out spontaneously impulses which result in movements of the respiratory muscles, constituting its automatism; and it may also be excited reflexly, *i. e.* by impulses reaching it from without

Its reflex center character is most marked and it is doubtless as a reflex center that its function is ordinarily performed

Reflex center, influenced by

1—Sensory nerves

Flagellation with a wet towel in case of narcosis

2—Vagus

Cutting both vagi decreases rate and increases depth of respiration

3—Higher brain centers

Psychic states influence respiration

4—Conditions of blood

Lack of oxygen, accumulation of CO_2, lowered temperature, lessened alkalinity of blood

L—FETAL RESPIRATION

By osmosis in the placenta; no direct transfer of blood. First breath due to accumulation of CO_2. Respiration in liquor amnii impossible because of inhibitory mechanism in nose

M—MODIFIED CONDITIONS OF RESPIRATION

I—Eupnea—Normal breathing

II—Hyperpnea—Increased breathing

III—Orthopnea—Breathing in upright position

IV—Apnea—Cessation of breathing

V—Cheyne-Stokes respiration

Irregular breathing in which a period of dyspnea alternates with a period of apnea

VI—Dyspnea—Difficult breathing

Causes:

A—Mechanical impediment

B—Lessened absorption power of lungs

C—Abnormal circulation

D—Difficult and rapid breathing due either to a lack of oxygen or to an excess of carbon dioxid in the blood. In oxygen dyspnea the inspirations are frequent and vigorous; carbon dioxid dyspnea is characterized by slow, deep and vigorous expirations

VII—Sighing

Results from a prolonged inspiration, the air passing noiselessly through the larynx and being expelled rather suddenly

VIII—Hiccough

Resembles sighing, but the inspiration is sudden due to a spasmodic action of the diaphragm

IX—Cough

Results from a deep inspiration followed by a forced and sudden expiration, during which the glottis is closed momentarily by the spasmodic action of the vocal cords

X—Sneezing

After a deep inspiration the air is directed through the nasal passages by a sudden and forced expiration

XI—Speaking

In this case there is a voluntary expiration and the vocal cords, being rendered tense by their muscles, vibrate as the air passes over them, producing sound. The chink of the glottis is narrow, the arytenoid cartilages are approximated, and the vocal cords are stretched. The arytenoid muscle approximates the arytenoids and the internal part of thyro-arytenoid closes the glottis. The vocal cords are made tense by the crico-thyroids and external part of the thyro-arytenoid. The pitch is dependent upon the length of the vocal cords—is higher in women than in men. Cracking of the voice is change of the childish treble to low-pitched adult voice, during which now and then a treble creeps in

XII—The epiglottis

Assists in preventing the entrance of food into the larynx during deglutition, and influences the timbre of the voice

XIII—Singing

Varies from speaking only in the differing tension and position of the vocal cords, and the consequently different sounds produced

XIV—Sniffing

Results from rapid repeated but incomplete inspirations

XV—Sobbing

Consists of a series of convulsive inspirations, during which the glottis is more or less closed

XVI—Laughing

Results from a series of short and rapid expirations

XVII—Yawning

An act of inspiration more or less involuntary, accompanied by a stretching of various facial muscles

XVIII—Sucking

This is caused chiefly by the depressor muscles of the os hyoides, which by drawing the floor of the mouth down and back, produces a partial vacuum

XIX—Asphyxia
Deficiency of oxygen in lungs or blood
Three stages
A—Bulbar stimulation, increased rate, increased amplitude, hyperpnea and dyspnea
B—Spinal stimulation, convulsion
C—Stage of exhaustion

DIGESTION

DEFINITION

The process by which the ingested food is prepared for absorption within the body. It is brought about by ferments, which have the following characteristics
1—Water necessary to their action
2—Require optimum temperature: boiling destroys, cold inhibits their action
3—Act by their mere presence
4—Accumulation of the products destroys their activity
5—Composition unknown
6—Action specific
7—Ferments are soluble in water, salt solution, or glycerin: are precipitated by alcohol

MECHANICAL PROCESSES

I—Deglutition
1—Buccal stage
The mouth is closed and the jaws are pressed together by the muscles of mastication
Lower jaw is raised by
1—Masseter
2—Temporal
3—Internal pterygoid
Lower jaw is lowered by
1—Digastric
2—Mylohyoid
3—Geniohyoid
Projection
1—External pterygoid
Retraction
1—Lower fibers of temporal
Lateral
1—External pterygoid acting separately

2—Pharyngeal stage

Return of the bolus to the mouth is prevented by the contraction of the palatoglossus which brings the anterior palatine arches in contact with each other, and raises base of the tongue. The larynx is pulled upward and forward, and the glottis is closed up by approximation of the vocal cords; this prevents food entering larynx. The soft palate is raised by the levator palati, the naso-pharyngeal cavity is closed, and the bolus is forced into the esophagus by the successive contraction of the three constrictor muscles of the pharynx

3—Esophageal stage

The food is forced down into the stomach by the peristaltic contraction of the esophageal muscles. Liquids are forced through the pharynx and esophagus by the vigorous contraction of the mylohyoid muscle. The first stage is voluntary. Second and third stages are reflex

Nervous Mechanism

Reflex

Afferent nerves 9–5–10 cranial nerves

Center in medulla

Efferent 12–11–10–5–9 cranial nerves

II—The vermicular movement of the stomach and intestines

1—Peristalsis of the stomach and intestines is a periodical process, produced by recurring progressive contraction of the walls, beginning in the stomach at the fundus and ending at the pylorus. It is attended by a rhythmical opening and closing of the pylorus. Each wave lasts 20 seconds, and is separated from the succeeding one by an interval of 20 seconds. The object is to force the contents in one direction. The peristalsis is more marked in the small bowel.

The nervous mechanism: The automatic center resides in the mesenteric plexus (Meissner) which is embedded in the muscular coat. Special nerve plexuses containing ganglia are found upon the blood vessels and lymph vessels of the intestinal walls. The nerves are the pneumogastric and the greater and lesser splanchnics. The pneumogastric increases peristalsis. It also contains inhibitory fibers. The splanchnic are the inhibitory nerves of the intestinal movement. The splanchnic also contain the nerves of sensation.

2—Another to and fro pendulum-like movement which mixes food

The function of the ileocecal valve

The valve consists of two semi-circular folds of mucous

membrane containing circular fibers. When the cecum is distended, the valve closes and prevents the regurgitation of the chyle into the large intestine

III—Muscular Movement of Small Intestine

The muscular movements of the large intestine are chiefly of the peristaltic or vermicular kind. This is a wave-like motion, characterized by a contraction of the circular fibers behind the bolus and a relaxation or inhibition in front. Under the influence of this peristaltic movement the contents of the large intestine (food residues and excrementitious matter) are gradually carried downward toward the sigmoid flexure, where they accumulate prior to their extrusion from the body. The effects of the peristaltic waves are to some extent interfered with by antiperistaltic waves, which, beginning in the transverse colon, run toward and to the cecum. The intestinal contents are thereby driven back toward the cecum. The effect is still further admixture with the secretions and exposure to the absorbing mucosa. There is some evidence also that the antiperistaltic wave may force some of the liquefied contents through the ileocolic opening into the small intestine because of the relaxation of the sphincter muscle.

IV—Addenda

1—Muscular and Nervous Mechanism of Defecation

A combined volitional and reflex act which begins with active peristalsis in the large intestine. The external sphincter is relaxed. Budge's anospinal center is the reflex center for defecation. Irritation of sensory nerves in the rectum by the feces causes a dilatation of the internal sphincter. During defecation, the reflex is inhibited by the inhibitory center which is voluntary. A deep inspiration is taken followed by an expiratory effort. The abdominal muscles are contracted, the rectum is straightened out and the feces pass through the anus

2—Food remains

A—Stomach 4 to 6 hours

The order in which alimentary principles leave stomach

1—Carbohydrates

2—Proteins

3—Fats

The higher the melting point the longer fat stays in stomach

B—Small intestines

9–23 hours

C—Large intestines
16–30 hours

CHEMICAL PROCESSES

Secretions

1—Saliva

A—Source—glands
a—Parotid
b—Sublingual
c—Submaxillary

B—Properties
Opalescent, tasteless, odorless; a ropy fluid; specific gravity 1.002–1.006. Alkaline reaction due to alkaline phosphates

C—Composition
Inorganic
Chlorids
Carbonates
Sulphates
Nitrates
} of Na. K. Ca. Mg.
Sulphocyanide of potassium
Organic
Albumin
Mucin
Ptyalin
Epithelial cell

D—Amount 1,500 cc. per diem

E—Functions
Physical
1—To moisten the mouth
2—To assist in the solution of the soluble portions of the food
3—To administer to the sense of taste
4—To lubricate the bolus of food, and thus
5—To facilitate the acts of mastication and deglutition
Chemical
1—The ferment ptyalin acts upon starch and changes it into
A—Soluble starch
B—Erythro-dextrin plus isomaltose
C—Achroo-dextrin plus isomaltose
D—Malto-dextrin plus isomaltose
E—Maltose plus maltose

F—Nerve Control
Sympathetic fibers, concerned in production of peculiar constituents of saliva
Cranial fibers, concerned in production of water and salts
Center situated in medulla
Paralytic secretion is secretion produced by cutting all nerve fibers to gland

2—Gastric Juice
Physical characteristics
a—Clear colorless fluid, acid in reaction, having sour taste, characteristic color, specific gravity 1.005
Composition
Water 94.5
Solids..... 5.5
Inorganic
Chlorids
Phosphates: of Na. K. Ca. Mg.
Hydrochloric acid 0.2%
Organic
A—Pepsin
B—Rennin
Amount
10–15 pints per diem
Function
a—Hydrochloric acid
1—Secretion
Secreted by parietal cells of fundic glands of stomach
a—$NaH_2PO_4 + NaCl = Na_2HPO_4 + HCl$
b—$2Na_2HPO_4 + 3CaCl_2 = 3Ca_3(PO_4)_2 + 4NaCl + 2HCl$
2—Function
A—Disinfection
B—Changes proteid into acid-albumin or syntonin
C—Forms acid medium necessary for action of pepsin
D—Inverts disaccharids
E—Stimulates flow of bile and pancreatic juice

b—Ferments

1—Pepsin, acts on proteids changing them into the following

A—Albumin

B—Acid albumin

C—Albumoses (proteosis)

a—Primary

Protalbumose

Hetero-albumose

b—Secondary

Deutero-albumose

D—Amphopeptone

a—Hemipeptone

Hexon bases (diamino-acids)

Arginin

Histidin

Lysin

Mono-amino acids

Tyrosin

Leucin

Aspartic acid

Tryptophan

b—Antipeptone (True peptone)

2—Rennin

Coagulates milk: casein of milk by hydrolysis breaks up into paracasein and whey-proteid

Mechanism of secretion

a—Indirectly: Reflex or psychic

Produced by anything that gives animal pleasure in eating

b—Directly

The mucosa contains a substance called progastrin, which is transformed by food into gastrin. Gastrin is absorbed by the blood and stimulates the glands of the stomach

3—Bile

Physical properties

A transparent fluid from yellow-brown to dark green, sweetish bitter taste, of musk-like odor, alkaline or neutral in reaction, specific gravity 1.026 to 1.032

Formation

The bile is formed in the biliary passages. The bile capillaries originate in the center of the acini,

lying midway between the two surfaces of adjacent liver cells. Leaving the acini they unite to form larger bile ducts, which merge at the transverse fissure as the hepatic duct. The latter unites with the cystic duct to form the common bile duct which enters the second part of the duodenum joined by the pancreatic duct, just before its termination. The dilatation of the common duct below the entrance of the pancreatic duct is known as the Ampulla of Vater

Composition

Water 86%

Solids 14%

Mucin and pigments

Bile salts

Taurocholate of sodium

Glycocholate of sodium

Fatty acids from soaps

Cholesterin

Lecithin and fats

Soluble salts

Insoluble salts

Amount

500–800 cc. per diem

Function

a—Aid in rendering alkaline the intestinal juice

b—Emulsify fats and oils

c—Form soaps and promote their absorption

d—Promote the absorption of fats by stimulation of the intestinal villi

e—Separate albumoses

f—Stimulate the production of trypsin

g—Produce intestinal peristalsis

h—Hold soaps and cholesterin in solution

i—Medium of excretion of pigments, cholesterin, and harmful compounds containing metals

4—Pancreatic Juice

Physical properties

Colorless, odorless, liquid; reaction alkaline

Composition

Water 97%

Proteins

Salts

Ferments

1—Trypsin

2—Amylopsin
3—Steapsin
The function of the pancreas is two-fold
a—Internal secretion
1—Secretes glycolytic ferment
b—External secretion
1—Secretes pancreatic juice
A—Steapsin
Splits up fats into fatty acids and glycerin
B—Amylopsin
Acts like ptyalin
C—Trypsin
Acts like pepsin
Amount
500–800 cc. per diem
Mechanism
The duodenal mucosa produces a pro-secretin, with addition of HCl yields secretin. When absorbed by the blood, secretin stimulates the pancreas

5—Intestinal Juice (Succus Entericus)
Physical properties:
Thin yellow fluid; contains Na_2CO_3, also mucin and other proteids
Function of its ferments
Erepsin
Breaks up peptones into amido-acids; completes action of pepsin and trypsin
Invertase
Inverts sugar, completes action of ptyalin and amylopsin
Enterokinase
Converts trypsinogen into trypsin

6—Bacterial action in large intestine
A—Zymogenic, producing ferments
B—Chromogenic, producing pigments
C—Pathogenic, producing disease
D—Toxicogenic, producing poisons

7—Functions of liver
A—Secretion of bile
B—Formation of urea
a—Formula $CO(NH_2)_2$
b—Molecular weight 60
c—Average quantity excreted: 30 gms. per diem

d—Origin
End product of proteid metabolism
e—Diminished excretion occurs in
1—Liver and kidney disease and also when
2—Low nitrogenous diet is used
f—Increased excretion occurs in
1—Chronic nutritional disease, such as diabetes; also occurs in
2—Acute infectious diseases, and when
3—Nitrogenous diet is used
g—Test
Biuret reaction
Add a few drops of Cu (SO_4) and alkalinize with Na (OH); violet red color indicates urea

c—Formation of uric acid
a—Formula $C_5H_4N_4O_3$
b—Origin
Albumins of tissues and ingested food, especially nucleoproteids
c—Description
Colorless, crystalline compound, slightly soluble in water, dibasic, forms neutral and acid salts
d—Chemical relation of uric acid to nucleins
1—Nucleoproteid
2—Proteid and nuclein
3—Proteid and nucleinic acid
4—Phosphoric acid and nuclein or xanthin, alloxuric or purin bases
The purin, $C_5N_4H_4$ under oxidative processes yields
A—Hypoxanthin (oxypurin) $C_5N_4H_4O$
B—Xanthin (dioxypurin) $C_5N_4H_4O_2$
C—Uric acid (trioxypurin) $C_5N_4H_4O_3$
e—Test for uric acid
Murexid test
Add a few drops of nitric acid, evaporate to dryness; addition of NH_4 (OH) yields a red color

D—Manufacture of heat
E—Conversion of poisonous into inert substance
F—Formation of creatinin
G—Reservoir of blood on way to heart
H—Formation and storage of glycogen

Formula—$C_6H_{10}O_5$

a—Origin

Carbohydrates of the food

b—Description

Amorphous, white, tasteless, odorless powder, soluble in water

c—Derived from the carbohydrate foods ingested

Is temporarily stored in the liver cells like starch in plants. It is an animal starch, a carbohydrate soluble in water. The liver cells act on dextrose ($C_6H_{12}O_6$), abstracting water (H_2O); the result is animal starch ($C_6H_{10}O_5$)

d—Fate

Glycogen transformed into dextrose and returned to circulation; hence hepatic vein contains more sugar than hepatic artery; glycogen ultimately oxidized in tissue

I—Formation of anti-thrombin

MISCELLANEOUS

Definitions

1—Chyme is a mixture of finely divided food and gastric juice, a semi-fluid, grayish, acid substance

2—Chyle is the fluid lymph contained in the lymphatic vessels of the digestive tract. It is alkaline in reaction and contains fats, glycerin lymph cells and small quantities of sugar and salts

3—Emulsification is the breaking up of fat into very small particles and the holding of them in suspension in a liquid

4—Saponification: replacing the glycerin of a fat by an alkali

5—The portal circulation

A—The blood collected from the capillaries of the spleen, stomach, and intestines by the splenic, gastric, and mesenteric veins, is carried by the portal vein to the liver. The portal vein breaks up into veins, running between the lobules, called interlobular veins. At the center the capillaries unite to form the central or intralobular vein; this unites with similar trunks to form the hepatic vein which empties into the inferior vena cava

B—The blood passing through the liver undergoes the following changes: During its progress it loses some of the proteid, fat, and inorganic substances; becomes more

coagulable; loses part of its sugar, urea is extracted; its temperature is lowered

c—Portal circulation carries the bulk of proteid, carbohydrate, alcohol, water, and salts, of the liver

d—The varieties of blood that circulate in the liver are

a—Arterial blood

1—Hepatic artery, a branch of the coelic axis

b—Portal blood

c—Hepatic vein collects venous blood and empties it into the inferior vena cava

6—Functions of stomach

A—Digestion

B—Absorption

C—Excretion

D—Reservoir

E—Antisepsis

7—Why the stomach does not digest itself

A—Alkalinity of the blood

B—Thick layer of mucous lining wall

ABSORPTION

A—DEFINITION

Transfer of digested food from alimentary canal to the blood

B—MECHANISM

Two theories

1—Vital selective action of epithelium lining intestine. Facts in favor

A—Substances absorbed have same, less, or greater osmotic tension

B—Sugar and peptones though less diffusible than Na_2 (SO_4), are absorbed more rapidly

C—Non-dializable substances are absorbed

D—Substances like peptones are changed in their passage through intestine

2—Mechanical theory. Facts in favor

A—Osmosis

B—Filtration

C—Capillary

D—Diffusion

C—CONDITIONS WHICH FAVOR ABSORPTION

I—Concentration
II—Heat
III—Condiments, such as pepper and salt

D—CHANNELS OF ABSORPTION

I—The capillary blood vessels
II—Lacteals in the small intestines

METHOD

I—Water, alcohol, salts, carbohydrates, and proteids enter the capil lary blood vessels and are carried by the portal vein to the liver They reach the general circulation by the hepatic vein

II—Absorption of fat: fats are absorbed as glycerin and fatty acid o soap. The fatty acid set free in the intestine is dissolved by th bile salts, together with the glycerin, is absorbed by the columna cells, during absorption a lipase which is contained in th columnar cells re-synthesizes, by reverse action, the glycerin an fatty acids. In this way minute fat particles are found nea the bases of the columnar cells. The fat globules are furthe taken up from the columnar cells by the lymphocytes. The fat : then deposited in the central lacteal by these cells, and in this wa it gets into the general lacteal stream and thence into the thorac duct. The bile salts, which have been absorbed by the columna cells, in all probability get into the portal vein radicle and in th way are taken back to the liver to be excreted again in the bile

III—Summary: all foods enter portal circulation except fats, whi enter by way of the lacteals

FOODS

A—CLASSIFICATION

Proteids
Carbohydrates
Hydrocarbons
Inorganic salts
Condiments

B—FUNCTIONS OF THE DIFFERENT FOOD PRINCIPLES

FOOD	*FUNCTION*
I—All substances containing nitrogen of a composition identical with or nearly that	I—Formation and repair of t sues and fluids of the body Regulation of the absorpti

of albumin; proportion of N to C. being nearly as two to seven	and utilization of oxygen
	These also form fat and carbohydrates, and yield energy sometimes
	Occur in most foods, both animal and vegetable. This class is largely converted into albumoses
II—Substances containing a larger proportion of N to C; about two to five and one-half; a less nutritious combination	II—These perform the above functions less perfectly or only under particular circumstances
III—Extractive matters, such as are contained in the juice of flesh.	III—These substances appear essentially as regulators of digestion and assimilation, especially with reference to the gelatin group
IV—Carbohydrates — substances containing no N, but made up of C, H and O, the O being exactly sufficient to convert all the H to H_2O	IV—Production of energy and animal heat by oxidation. Form fats and possibly some proteids
V—Fats—substances containing no N, but made up of C, H and O, the proportion of O being less than sufficient to convert all the H to H_2O	V—Supply of fatty tissues, nutrition of nervous system, supply to energy and animal heat by oxidation
VI—Salts	VI—Support of bony skeletons, supply of HCl for digestion; regulation of energy and nutrition

C—*SUMMARY OF ACTION OF FOODS*

Value of food is measured by its power to produce heat. The unit is the calorie, or the amount of heat required to raise the temperature of one kilogram of water, one degree centigrade

1—The heat value of carbohydrates equals four calories per gram

2—The heat value of proteids equals four calories per gram

3—The heat value of fats equals eight to nine calories per gram

In order to supply the requirements of the organism a certain amount of potential energy is needed

During rest in bed	1800	calories
In repose	2100	"
In light work	2300	"
In moderate work	2600	"
In hard work	3100	"

The number of grams of proteids, hydrocarbons and carbohydrates required daily can be converted into calorimetric equivalents

The quantity of proteid consumed daily is	100 gm. × 4.1 =	410
The carbohydrates consumed daily are	500 gm. × 4.1 =	2050
The hydrocarbons consumed daily are	50 gm. × 9.3 =	465
		2925

Function

1—Carbohydrates
- Production of energy
- Production of heat
- Formation of fats

2—Hydrocarbons
- Production of heat
- Production of energy
- Nutrition of nervous system

3—Proteids
- Repair of body waste

4—Salts
- Production of skeleton
- Production of HCl
- Regulation of nutrition and energy

5—Water
- A—Enters into the composition of all the tissues and fluids of the body
- B—Moistens the surfaces and membranes
- C—Keeps the fluid of the body at their proper degree of dilution
- D—Removes waste matter
- E—Distributes and regulates body heat
- F—Prevents friction

D—MISCELLANEOUS

I—Effects of cooking of foods
- 1—Softens the food so that it may be more easily masticated
- 2—Destroys all parasites and disease germs
- 3—Develops certain flavors

4—Breaks up the cellular coat of starch so that the granules may be more easily acted upon by the gastric juice; changes some of the starches to dextrin

5—Coagulates proteids

II—Adipose tissue is deposited in fat droplets in the panniculus

1—Its action

A—Lubricates and prevents friction

B—Protects body against cold and mechanical injury

C—Gives rotundity to the body

D—Forms a reserve store of nutriment and fuel

2—Fats are broken up into H_2O and CO_2

III—Alcohol as a food

1—Alcohol is broken up into CO_2 and H_2O. As this change takes place easily it diminishes the consumption of constituents of the body. Alcohol replaces fat only in small quantities. It aids digestion, stimulates circulation and the nervous system. In large quantities it is a poison, stimulating the production of connective tissue

2—It may supply food in temporary privation, and protect tissues of the sick from too rapid consumption

IV—Composition of Human Milk

	Human Milk	*Cow's Milk*
Fat	4.00	4.00
Sugar	7.00	4.50
Proteids	1.50	3.50
Salts	0.20	0.75
Water	87.30	87.25
	100.00	100.00

METABOLISM

A—DEFINITION

A name given to the process of building up (ANABOLISM) of the body and breaking down (KATABOLISM). The object is to build up new tissues and repair loss; to store up food material and convert it into fuel. The chemical changes consist of

1—Hydration

2—Dehydration

3—Reduction

4—Oxidation

B—METABOLIC EQUILIBRIUM

Condition in which same quantity of material is taken up and assimilated, as it is removed from the body

Normally during twenty-four hours there are taken into the body:

Food (chemically dry)	16	ounces
Water (as drink and combined with solid food)	80	"
Oxygen (absorbed by lungs)	26	"
Total	122	ounces

These substances are converted into relatively simple bodies and leave through the ordinary excretory channels:—lungs, skin, kidneys, and intestines

From the lungs there are exhaled every twenty-four hours:

Of carbonic acid, about	30	ounces
Of water	10	"
	40	ounces

From the skin

Water	23	ounces
Solid and gaseous matter	1	ounce
	24	ounces

From the kidney

Water	50	ounces
Organic matter	1½	"
Minerals and salines	½	ounce
	52	ounces

From the intestines

Water	4	ounces
Various organic and mineral substances	2	"
	6	ounces
Total	122	ounces

The income and expenditures of the normal adult body balance each other

C—NITROGEN METABOLISM

All the nitrogen is excreted in the form of urea, excepting about 2% excreted as uric acid and creatinin four to five per cent. excreted in the feces; traces in expired air. A well-balanced diet is here made the basis of computation: one part nitrogenous to four parts non-nitrogenous material. An exclusive meat diet requires more work on the part of the digestive organs than they can stand.

D—METABOLISM OF THE EMBRYO

I—At first the ovum absorbs nutriment simply through the vitelline membrane, while passing through the Fallopian tube. The nutrient material is supplied by the secretions of the tube itself, or may consist in part of seminal fluid introduced from without

II—The vitellus is absorbed by the entoderm lining, the umbilical vesicle and alimentary canal, and later is absorbed and conveyed into the body of the embryo by the blood vessels of the area vasculosa

III—When these contents of the umbilical vesicle are exhausted the chorial villi appear and take up nourishment from the uterine decidua, with which they are in contact

IV—With the disappearance of villi in the chorion, the villi of the decidua serotina develop into the placenta, which takes up nutriment from the maternal blood by which it is surrounded

V—The placenta not only affords nutriment to the fetus but is also its respiratory organ. The umbilical arteries carry blue (venous) blood to the placenta, where carbonic acid gas is given off to the maternal blood and oxygen is taken in from it, so that the umbilical vein brings back arterial (red) blood to the fetus. The placenta is also an organ of excretion for the fetus. Recently the placenta has been credited with a selective function, by which it has power to select from the maternal blood such materials as may be required by the fetus at different periods of pregnancy

E—SUMMARY OF DIGESTION

In considering the changes that take place in a meal composed of an egg sandwich and a glass of water, the first step in the reasoning process is to break it up into its food principles. The egg is proteid, bread is carbohydrate, the butter on the bread is a hydrocarbon, the pepper is a condiment, the water an inorganic principle

Buccal Digestion

Mechanical phase

The saliva dissolves certain elements and administers to the sense of taste, the movements of mastication convert the food into a bolus

Chemical phase

The ptyalin acts on the carbohydrate (bread) and breaks it up into

Amylo-dextrin and isomaltose
Erythro-dextrin and isomaltose
Achroo-dextrin and isomaltose

Malto-dextrin and isomaltose
Maltose and maltose

Not all these changes take place in the mouth; the food does not remain long enough. The proteid (egg) is not acted upon chemically in the mouth. Mechanically the proteid is crushed and its connective tissue sheath is broken

Gastric Digestion

The food, mixed with saliva, is carried into stomach by process of deglutition

Mechanical

The to and fro movement of the stomach mixes gastric juice with the food and converts it into chyme

Chemical

A—The hydrochloric acid changes the bolus from alkaline to acid in reaction, and converts the proteid (egg) into acid albuminate

B—Pepsin acts on acid albuminate of egg and by a series of hydrolyses breaks it up into

a—Albumin
b—Acid albumin
c—Albumoses (proteosis)
1—Primary
2—Secondary
d—Amphopeptone
1—Hemipeptone
2—Antipeptone (True peptone)

Not all these changes take place in stomach; the food does not remain long enough

C—Rennin coagulates milk, by hydrolytic cleavage breaking it up into paracasein and whey proteid. Paracasein unites with calcium to form an insoluble curd. Further digestion of milk is carried on by ferments of stomach and intestine

Pancreatic Digestion

A—Trypsin of pancreatic juice completes work of pepsin

B—Amylopsin completes work of ptyalin

C—Steapsin acts on fats, breaking them up into fatty acids and glycerin. Fatty acids unite with alkaline salts of bile (sodium taurocholate and sodium glycocholate), to form a soap, which emulsifies the remaining unaltered fat. According to another view the fatty acids and glycerin are absorbed as such and recombine to form neutral fats

Intestinal

A—Invertin completes action of ptyalin and amylopsin, converting the starch (bread) into maltose

B—Erepsin completes action of pepsin and trypsin on proteids, converting them into peptones

Bacterial action in large intestine

A—Decomposes proteids, starches and fats into simpler molecules

F—ABSORPTION

I—Proteids and carbohydrates enter portal circulation mechanically or vitally and are carried to liver, which converts proteid into urea and the end product of carbohydrate digestion into glycogen

II—Fats are absorbed by the lacteals, mechanically or vitally

G—METABOLISM

The function of the proteid in the egg of the sandwich is the repair of body waste; caloric value four. The purpose of the carbohydrate —bread—is to give heat and energy, especially energy; caloric value four. The function of hydrocarbon—butter—is to give heat and energy, especially heat; caloric value nine. All these changes take place by oxidation, reduction, hydration, and dehydration. The inorganic principle, water, requires no digestion; enters circulation as water. The condiment pepper stimulates appetite and increases flow of gastro-intestinal juices

The undigested or indigestible food is carried by peristaltic action into the rectum, where the process of defecation expels the feces

NERVOUS SYSTEM

NERVOUS SYSTEM—General Considerations

Definitions

1—Life is the sum total of vital activity. Characteristics:

A—Irritability, or power of responding to a stimulus

B—Power of movement

C—Power of assimilation

D—Power of growth

E—Power of excretion

F—Power of reproduction

2—Death is the cessation of the vital functions

3—Sleep is a condition of partial or complete unconsciousness during which the brain and body can recuperate. Metabolism in general is diminished, anabolism being relatively in

excess of katabolism. During sleep, secretions are diminished, the pulse is slower, the eyeballs roll inward and upward, and oxidation in the tissues is decreased. The cause of sleep is not known. Theories:

A—Cerebral anemia

B—Chemical changes in the brain cells or neurons such as an exhaustion of their intramolecular oxygen or an accumulation of fatigue products

C—Contraction of the dendritic processes and a consequent break in the transmission of nerve impulses

D—Expansion of the neuroglical cell processes, insulating the nerve processes and producing the same effect

E—Loss of consciousness apart from any physical or chemical change

F—The most probable hypothesis is that of an altered metabolism of the cerebral cells dependent upon exhaustion and diminished influx of stimuli. Recently two new theories have been promulgated; one attributes the causation of sleep to an internal secretion of the pituitary body, the other makes it due to osmosis. Toward the period of awakening, the psychic activities may reappear in the form of dreams consisting of hallucinations. During sleep there is local anemia of the brain, the general blood pressure is lowered, all psychic activity is abolished

4—Neuron: Doctrine

A—No nerve fiber independent of nerve cell

B—The cell with all its prolongations is a unit

C—These units act by contact

D—The entire nervous system is made up of superimposed units

E—The units are so arranged that impulses can pass only in one direction

F—Every part of a neuron is dependent for its nutrition on the nucleus of the cell body

G—When a nerve fiber is severed, regeneration of the axis cylinder is accomplished by outgrowth from the central end; there is no auto-regeneration

5—Physiology of cell body

A—A nerve cell can transform a single stimulus into a long continued effect

B—Rate of discharge 40–100 meters per second

C—Fatigue

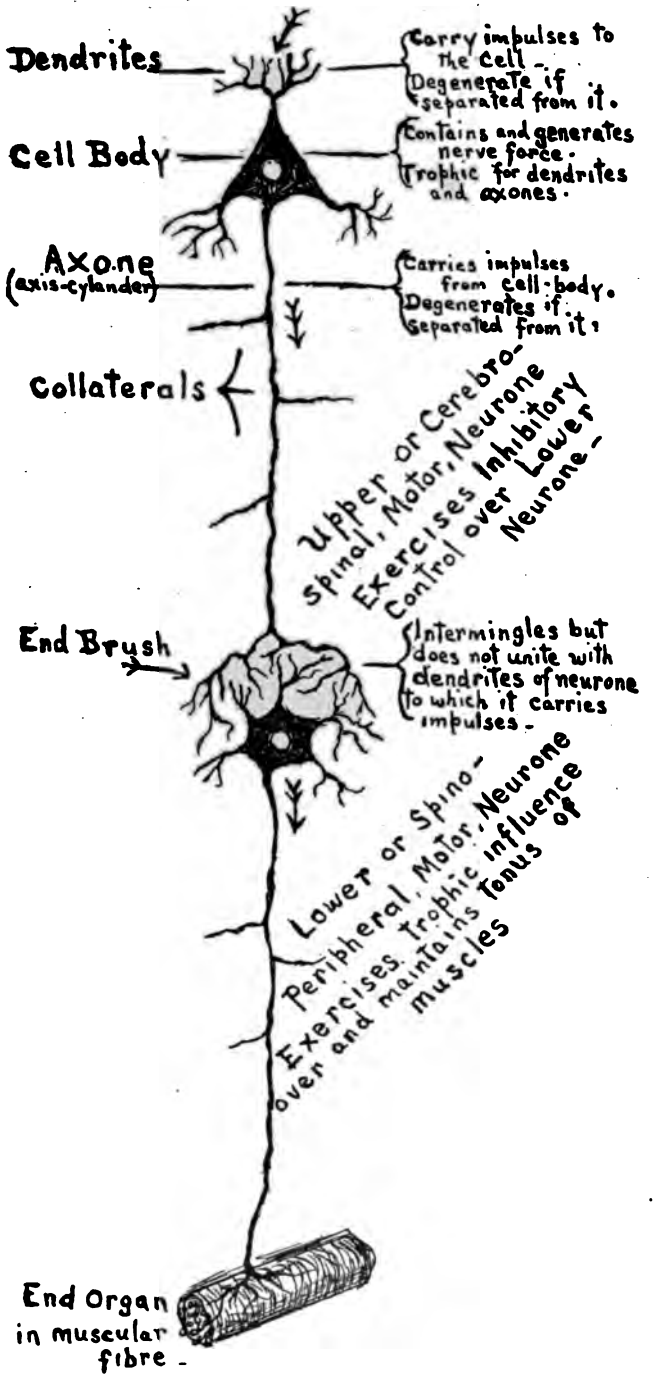

Dendrites
Carry impulses to the Cell - Degenerate if separated from it.
Cell Body
Contains and generates nerve force. Trophic for dendrites and axones.
Axone (axis-cylander)
Carries impulses from cell-body. Degenerates if separated from it.
Collaterals
Upper or Cerebro-spinal, Motor, Neurone Exercises Inhibitory Control over Lower Neurone -
End Brush
Intermingles but does not unite with dendrites of neurone to which it carries impulses -
Lower or Spino-Peripheral, Motor, Neurone Exercises trophic influence over and maintains tonus of muscles
End Organ in muscular fibre -

FIG. 34.—Diagram of Neurones

a—Volume of cell smaller; protoplasm becomes vacuolated
b—Nucleus shrinks and becomes crenated
c—Nissl's bodies become less
d—Cell body becomes acid due to CO_2
e—Oxygen is decreased
f—Production of heat decreases
g—Fatigue bodies are formed

6—Synopsis
Changes in impulse
a—Irreciprocity of conduction: in the fiber, the impulse passes in both directions; in the cell in only one direction
b—Retardation of impulse rate
c—Great susceptibility to fatigue
d—Summation of stimuli
e—Susceptibility to drug action

7—Reflex is
Coördinate movement without intervention of will.
Necessary factors
a—Afferent nerve
b—Efferent nerve
c—Synopsis between 1 and 2 called reflex center
Reflex time .008–.015 second
Characteristics of reflex
a—Involuntary
b—Follows immediately upon stimulation
c—Result machine-like, performed against the will
d—Useful
Classification as to location
a—Superficial-cutaneous
1—Coughing (larynx)
2—Winking (eyelid)
3—Sneezing
b—Deep, tendinous
1—Knee jerk
2—Inferior maxillary reflex
c—Organic-visceral
1—Alimentary canal (swallowing)
2—Circulatory, cardiac and vaso-motor
3—Respiratory
4—Urogenital
5—Eye
6—Skin

8—Functions of the cerebral cortex

A—Sensation

B—Intelligence

C—Consciousness

D—Memory

E—Ideation

F—Volition

G—Association areas of the brain

Definition

Where elaborated impressions arrive from all the sensory areas and are combined into perceptions and conceptions

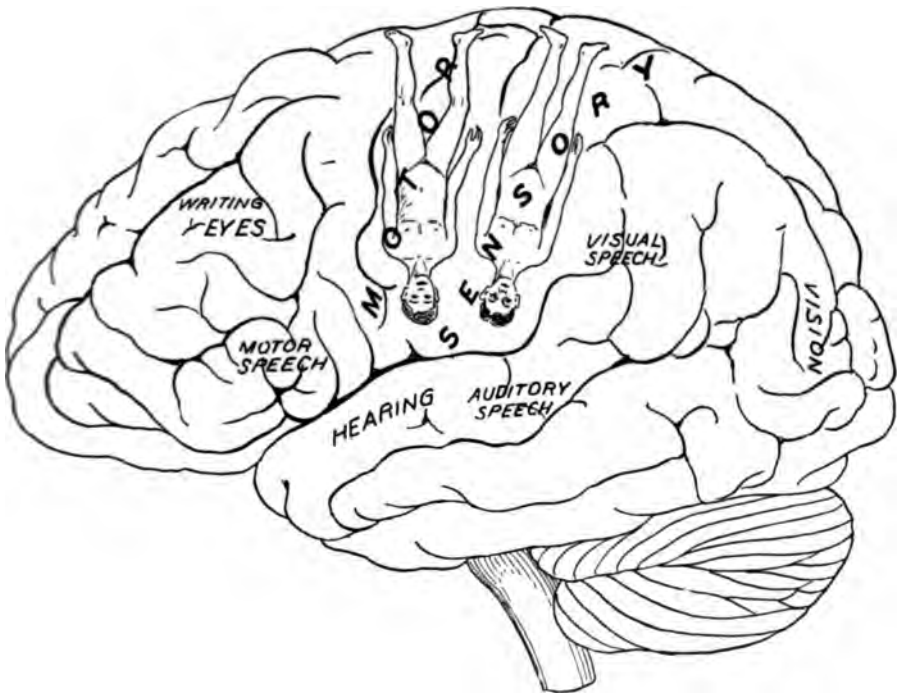


FIG. 35.—Diagram Showing Cortical Localization

Four association areas are described

Frontal anterior to the motor area

Parietal, between the general sense areas and the visual area

Temporal, occupying the greater part of the temporal lobe

Insular, the island of Reil

Localization

9—Definition

Aphasia
Total or partial loss of the power of expressing or comprehending spoken or written words
Motor aphasia
Inability to express thought
1—Speech-aphemia
2—Writing-agraphia
Sensory aphasia (amnesia)
1—Word deafness (auditory amnesia)
2—Word blindness (alexia)

10—Cerebellum
Function
a—Equilibration
b—Coördination
c—Inhibition over skeletal muscles
Lesion produces
a—Asthenia .....Muscle weakness
b—Atonia .....Loss of tone
c—Astasia .....Loss of steadiness of contraction

11—Medulla
A—Connects brain with cord
B—Receives impulses
C—Location of centers:
a—Respiratory
1—Coughing
2—Sneezing
3—Phonation
b—Vasomotor
c—Cardio-inhibitory
d—Tongue muscles and esophagus
e—Secretion
1—Sweat
2—Saliva
3—Gastric juice
f—Pupillary dilation
g—Convulsion center

12—The sympathetic nervous system:
A—Composition
a—A series of ganglia connected by two great ganglionic cords, extending from the base of the skull to the coccyx; one ganglionated cord on each side of the middle line of the body, partly on each side of the vertebral column

b—Three great ganglionated plexuses or aggregations of nerves and ganglia, situated in front of the spine in the thoracic, abdominal and pelvic cavities respectively

c—Smaller or terminal ganglia, situated in relation with the abdominal viscera

d—Numerous fibers (*See* Anatomy)

B—Functions of the sympathetic system:

a—Controlling influence over the secretion of most of the glands: the lacrymal, the salivary, the sweat glands, the glands of the stomach and intestines; the liver, the kidney, etc.

b—Presides over the circulation by regulating the caliber of the blood-vessels and the action of the heart

c—Influences respiration

d—All involuntary muscles; those of the digestive apparatus, of the genito-urinary system, of the hair follicles (pilomotor nerves); all vegetative life of the organism is under the control of the sympathetic system; called the vegetative nervous system

13—Cord

Functions of the spinal cord

a—The conduction of nerve impulses

b—Reflex action

c—Coördination

d—It also contains special centers which preside over definite functions

In the spinal cord

a—The white substance simply conducts nerve impulses

b—The gray substance contains groups of cells which act as centers for and distributors of nerve impulses and are also concerned in reflexes

c—The anterior cornua have a motor and trophic function

d—The posterior cornua are sensory

14—Functions of Cranial Nerves (*See* Section on Anatomy)

A—Olfactory—special sense of smell

B—Optic—special sense of sight

C—Motor oculi, motor; control all muscles of eye except the superior oblique and external rectus

D—Trochlear—motor to superior oblique

E—Trifacial—compound or mixed

a—Ophthalmic branch, supplies sensation to conjunctiva and skin of upper eyelid, cornea, skin of forehead and nose, lachrymal glands, mucous membrane of nose

b—Superior maxillary branch, supplies sensation to skin and conjunctiva of lower lid, nose, cheek, upper lip, upper teeth, alveolar processes and palate

c—Inferior maxillary branch, supplies sensation to external auditory meatus, side of head, mucous membrane of mouth, anterior two-thirds of tongue, lower teeth, lower lip and skin of the lower part of the face. This branch in addition, supplies motion to the muscles of mastication (masseter, temporal, external pterygoid, internal pterygoid), also to mylohyoid and anterior belly of digastric

F—Abducens, motor to external rectus

G—Facial, motor to expression muscles of face

H—Auditory, special sense of hearing and equilibrium

I—Glosso-pharyngeal—compound or mixed

J—Vagus, compound or mixed

Throughout its whole course the vagus contains both sensory and motor fibers. To summarize the many functions of this nerve—it may be said that it supplies

1—Motor influence to the pharynx and esophagus, stomach and intestines, to the larynx trachea, bronchi and lungs

2—Sensory, and in part

3—Vasomotor influence, to the same regions

4—Inhibitory influence to the heart

5—Inhibitory afferent impulses to the vaso-motor center

6—Excito-secretory to the salivary gland

7—Excito-motor in coughing, vomiting, etc.

K—Spinal accessory—motor to trapezius and sterno-mastoid muscles

L—Hypoglossal—motor to tongue

15—Nerves

Function

Furnish connection between central nervous system and peripheral organs

Classification

a—Centripetal—afferent

b—Centrifugal—efferent

Function

a—Irritability
b—Conductivity

Law of Double Conduction
a—Nerve conducts impulses in both directions

Law of isolated conduction
An impulse passing along one fiber is not communicated to neighboring fibers

Velocity
50–125 meters per second

Normal reaction of nerve to electricity
K C C, A C C, A O C, K O C

Reaction of degeneration
A C C, K C C, K O C, A O C

EYE

—EYE, ORGAN OF

I——Color
II——Light
III——Form

—MECHANISM

Rays of light from external objects are focused on the retina, and start nerve impulses which are transmitted by the optic nerve and optic tract to the center for sight in the cortex of the brain. The following diagram will show how the image is formed on the retina

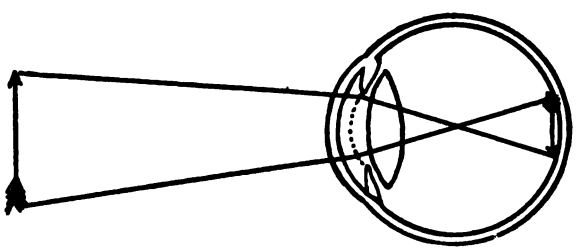


Fig. 36.—Diagram of the Formation of an Inverted Image

C—ACCOMMODATION

The lens is an elastic structure, and when released from the flattening influence of its suspensory ligament tends to assume a spherical shape. During accommodation the ciliary muscle, especially the circular fibers contract, drawing forward the choroid and relaxing the suspensory ligament; this diminishes the tension of the lens to increase its convexity. The change in curvature affects chiefly the anterior surface of the lens. This is Helmholt's theory and the one usually accepted. Lately Tscherming has advanced a different

theory. He maintains that the ciliary muscle increases the sion of the suspensory ligaments during contraction and that causes peripheral flattening of the lens with bulging anteriorly its center. The act of accommodation is accompanied by contrac of the pupil and (in binocular vision) by convergence of the vi lines

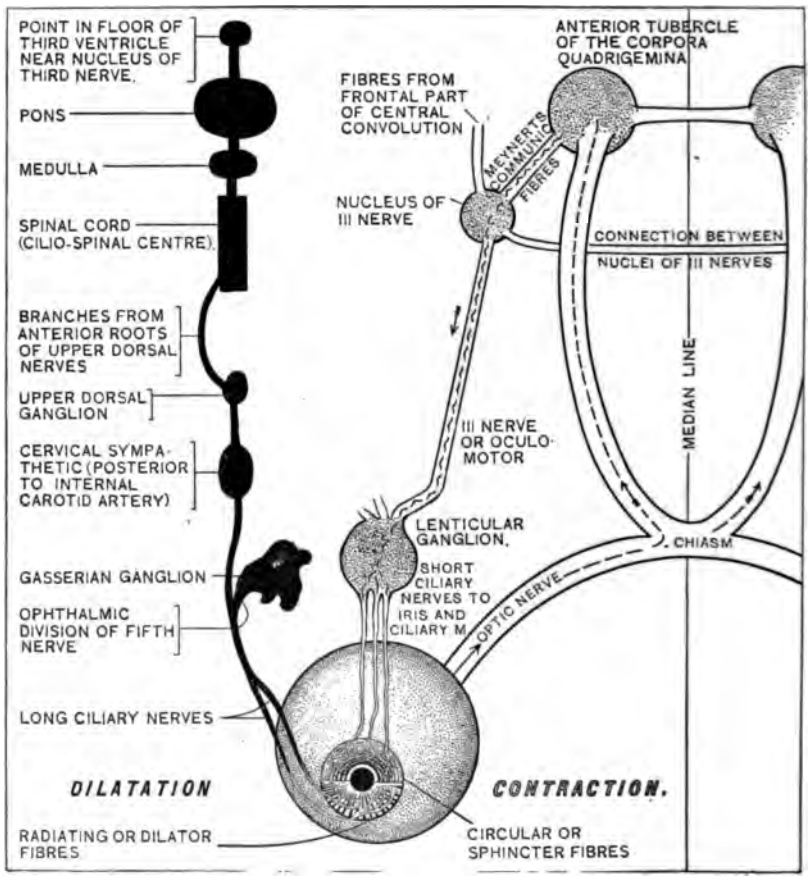

POINT IN FLOOR OF THIRD VENTRICLE NEAR NUCLEUS OF THIRD NERVE.
PONS
MEDULLA
SPINAL CORD (CILIO-SPINAL CENTRE).
BRANCHES FROM ANTERIOR ROOTS OF UPPER DORSAL NERVES
UPPER DORSAL GANGLION
CERVICAL SYMPATHETIC (POSTERIOR TO INTERNAL CAROTID ARTERY)
GASSERIAN GANGLION
OPHTHALMIC DIVISION OF FIFTH NERVE
LONG CILIARY NERVES
DILATATION
RADIATING OR DILATOR FIBRES
FIBRES FROM FRONTAL PART OF CENTRAL CONVOLUTION
NUCLEUS OF III NERVE
MEYNERT'S COMMUNICATING FIBRES
ANTERIOR TUBERCLE OF THE CORPORA QUADRIGEMINA
CONNECTION BETWEEN NUCLEI OF III NERVES
MEDIAN LINE
III NERVE OR OCULO-MOTOR
LENTICULAR GANGLION.
CHIASM
SHORT CILIARY NERVES TO IRIS AND CILIARY M.
OPTIC NERVE
CONTRACTION.
CIRCULAR OR SPHINCTER FIBRES

FIG. 37.—Nervous Mechanism of the Iris

Path of sensory stimulation through optic tract.
Path of motor impulse through third nerve to sphincter fibers, causing dilatation of pupi
Solid black-path of impulses from point near nucleus of third nerve and cilio-spinal center thr sympathetic to dilator fibers, causing dilatation of pupil.

D—FUNCTIONS OF RODS AND CONES

The rods and cones are both concerned in vision, but they diffe structure and in function. The rods are most abundant at the per ery of the retina and the cones in the central area. The gener accepted theory is that the rods are most concerned with visior dim light, and with the form of objects, and that the cones are chi concerned with vision in ordinary light and with the color of obj

E—FAR AND NEAR POINTS

Far point 20 feet and beyond

Near point 6 inches

Amount of accommodation between these two points is eight diopters; called Range of Accommodation

F—IRIS

I—Cuts off marginal rays

II—Regulates light that enters eye

III—Assists in accommodation

G—PUPIL CONTRACTED BY

I—Bright light

II—Accommodation for near vision

III—Convergence of eyes

IV—Sleep

V—Drugs

MECHANISM

In the changes which take place in the iris, two sets of nerves are involved

1—Those of the third nerve or oculomotor

2—Nerves of sympathetic origin. The third nerve supplies the circular fibers, and consequently section of this nerve paralyzes these fibers, and dilatation of the pupil occurs. When the third nerve is stimulated, the circular fibers contract, causing a diminution in the size of the pupil. The sympathetic supplies the radiating fibers and its section paralyzes those fibers, causing contraction of the pupil, while its stimulation produces dilatation. When light falls upon the retina this portion of the eye is stimulated and the impression is carried by the optic nerve to the brain; there motor impulses are generated which are transmitted through the third nerve to the sphincter of the iris causing it to contract; this is, therefore, a reflex act

H—DEFECTS OF NORMAL EYE

I—Spherical aberration, peripheral rays come to focus sooner than central rays

II—Chromatic aberration, different wave lengths, different refraction

III—Entoptic phenomena, muscae volitantes, vision of opaque bodies in eye

I—DEFINITIONS

I—Myopia, short sight: rays are focussed in front of the retina, due to increased length of the antero-posterior diameter of the eye: requires concave lens

II—Hypermetropia, far sight; rays are focussed in back of the retina due to shortened antero-posterior diameter; requires a convex lens

III—Astigmatism, defect of sight due to irregularities in the cornea different rays are not refracted alike; cylindrical concave or convex lens required

IV—Emmetropic, normal eye

V—Presbyopia, a gradual failure of the power of accommodation dependent on the progressive loss of elasticity in the lens and the loss of its power to increase its refraction. The near point recedes and the range of accommodation is diminished

VI—Aphakia; absence of lens; convex lens required

VII—The point of the most acute vision; fovea centralis

VIII—Rhodopsin, visual purple

J—POSITIVE AFTER IMAGE

Sensation of light lasts longer than the stimulus, hence a positive after image; for this reason, a live coal moved rapidly appears as a streak of light

K—COLOR VISION—Theories

I—According to one theory the nervous elements of the retina are uniform in type, but are affected in different ways by variously colored lights, depending on different wave-lengths in the vibrations of ether, rapidity of vibration, and refractive exponent

II—The Young-Helmholtz theory assumes the existence of three different sets of retinal fibers, corresponding to the primary colors. Stimulation of the first set produces the sensation of red, of the second, green, and of the third violet. Stimulation of any two sets of fibers produces the impression of a mixed color; the stimulation of all, the sensation of white. The cones alone are supposed to be concerned in light perception, the rods merely with the power of distinguishing between quantitative sensations of light

III—According to the Ewald-Hering theory there is one set of fibers, while there are three chemical substances found in visual purple. The anabolism of these causes white, red, and yellow; katabolism, black, green and blue. Various combinations cause various shades

L—NEGATIVE AFTER IMAGE

Suppose a person looks at a red light for a long time: katabolism occurs in the red organs until exhausted. If he looks at white light, sensation of green is produced

*M—COLOR BLINDNESS—(Dichromatic eye, **Daltonism**)*

The normal eye is trichromatic

N—VISUAL FIELD

Instrument for measuring same is called a perimeter. When both eyes are fixed on a given object, the fields overlap. That part common to both eyes is called the binocular field of vision

O—VISUAL ACUITY

Determined by noting the distance at which test letters (Snellon's type) of a certain size can be read. The letters being at 20 feet, no accommodation letters subtend an angle of five degrees. If the patient can read this the vision is said to be normal. If these same letters can be read only at five feet, the visual acuity is only one quarter or five-twenty

EAR

A—SOUND—The normal stimulus for the ear

B—QUALITIES—Sound is due to vibrations of air

I—Pitch—depends on number of vibrations per second
II—Intensity—depends on amplitude of vibrations
III—Color—timbre—depends on wave form

C—FUNCTIONS OF EAR

I—Auricle
Collects sound
II—External auditory meatus
1—Protects drum from foreign bodies
2—Protects from injury
III—Tympanic membrane
Responds to tones
IV—Eustachian tube
Keeps air in either side of drum equal
V—Ossicles
Malleus, incus and stapes: transmit sound to oval window causing perilymph in scala vestibuli to be thrown into vibration; this causes endolymph in canal cochlearis to vibrate
VI—Range of Hearing
24–40,000 vibration per second
VII—Functions of semi-circular canals:
1—Tactile impressions from feet
2—Motorial impressions from muscles and tendons
3—Visual impressions
4—Labyrinth impressions

D—CONDUCTION

The waves of sound are gathered together by the pinna and external auditory meatus, and conveyed to the membrana tympani. The membrane, made tense or lax by the action of the tensor tympani and laxator tympani muscles, is enabled to receive sound waves of either high or low pitch. The vibrations are conducted across the middle ear by a chain of bones to the foramen ovale, and by the column of air of the tympanum to the foramen rotundum, which is closed by the second membrana tympani, the pressure of the air in the tympanum being regulated by the Eustachian Tube. The internal ear finally receives the vibration which excites vibrations successively in the perilymph, the walls of the membraneous labyrinth, the endolymph, and lastly the terminal filaments of the auditory nerve (organ of Corti) which is the receptive apparatus for hearing. It analyzes sound and translates the vibrations of physical sounds into physiological nerve stimuli. In this form they are conveyed to the medulla by the superior olive, lateral fillet, and posterior quadrigeminal body to the auditory center in the temporal lobe

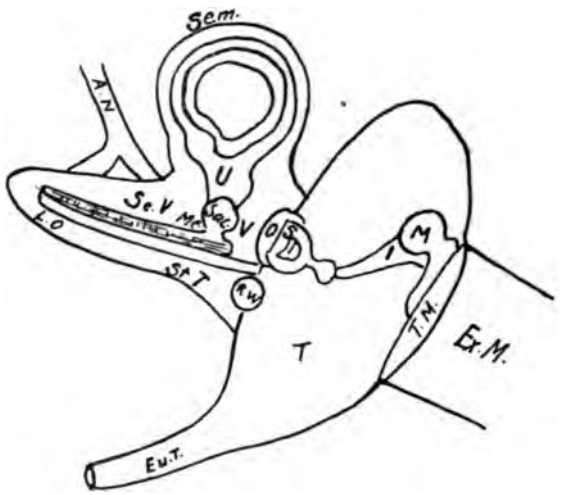


FIG. 38.—Parts of the Ear

Ex. M., External meatus; T. M., Tymp. Memb.; T, Tympanum; S, Stapes; I, Ineus; M, Malleus; R. W., Round Window; Sem., Semilunar canal; U., Utriculus; Sac., Sacculus; V., Vestibule; Sc. V., Scala Vestibule; Sc. T., Scala Tympani; O., Oval Window; M. C., Memb. Cochlea; L. O., Lamina ossea; Eu. T., Eustach. tube; A. N., Auditory N.

TASTE

A—DEFINITION

Subjective sensation of tongue

B—CLASSIFICATION

I—Bitter, back of tongue

II—Sweet, and salt, tip of tongue
III—Sour, at sides of tongue

C—NERVES

Taste

Posterior one-third of tongue: 9th cranial subserves function of sensation and taste. Anterior two-thirds supplied by lingual with ordinary sensation; chorda tympani gives special sense of taste

FIG. 39.—Diagram Showing the Motor and Sensory Supply of the Tongue
MOTOR Hypo-Glossal; SENSORY Glosso-Pharyngeal; Trigeminus; Chorda tympani; Chorda Tympani

SMELL

FUNCTIONS OF NOSE

I—Prepares air for lung: warms it, moistens it, and removes dust
II—Olfaction

TOUCH

A—TOUCH—Perceived by pressure organs

Paccinian bodies (tactile corpuscles)

1—Deep or subcutaneous
2—Protopathic

Respond to temperature above 37 degrees C. and below 26 degrees C. but not to changes in temperature between those limits

3—Epicritic

Ability to distinguish between 37 degrees C. and 26 degrees C.

After sensation

1—If the skin is stimulated 480–600 per second the after sensations fuse and give the sensation of a single stimulus

B—SENSE OF TEMPERATURE

Two sets of nerves corresponding respectively to heat and cold

PAIN

ORIGIN OF PAIN

I—Excessive stimulation of touch, cold or heat nerves

II—Special pain nerves

Pain is referred to ending of nerves. The viscera have no pain points; pain felt here is due to affection of peritoneum

HUNGER

A—DEFINITION

Peculiar sensation referred to epigastrium characterized by

1—Feeling of weakness

2—Desire for food

THIRST

PROJECTED TO THE PHARYNX

I—Real thirst is lack of water in system

II—Pharyngeal or local thirst, is due to dust, etc.

SECTION IV

CHEMISTRY

DEFINITION

The science which treats of the **properties and composition of matter and** the laws governing such composition

1—Inorganic Chemistry

Science of compounds **not containing combustible carbon**

2—Organic

Science of compounds **containing combustible carbon**

3—Physiological

Science of metabolic changes

GENERAL PRINCIPLES

I—Valence

Definition

Ability of atoms to unite with each other compared with hydrogen which has a valence of one

Classified

A—**Monad (univalent)—having the combining power of one hydrogen**

Example—Hydrogen, Chlorin, Sodium

B—Diad (bivalent)—having the combining power of two hydrogens

Example—Oxygen, Barium, Copper

C—Triad (trivalent)—having the combining power of three atoms of hydrogen

Example—Nitrogen, Phosphorus, Bismuth

D—Tetrad (quadrivalent) having the valence of four atoms of hydrogen

Example—Carbon, Platinum

Nomenclature

A—Artiads

Elements of even valence

B—Perisads

Elements of uneven valence

Philosophy

Equal valences always unite

Example

HCl—Formula for hydrochloric acid. Chlorin has a valence of one, because it unites with one atom of hydrogen which has a valence of one

H_2O—Formula for water, Oxygen has a valence of two because it takes two hydrogen atoms to unite with it

PbO—Formula for lead oxide, Valence of lead is two because it unites with oxygen which is two. Then to build the formula for lead chlorid it is necessary to take one lead and unite it with two chlorins, because chlorin has a valence of one: $PbCl_2$

$BiCl_3$—Formula for bismuth chlorid, valence of bismuth is three because it unites with three chlorins. To build the formula for bismuth oxid it is necessary to unite bismuth (valence of three) with oxygen (valence of two) in such proportion that the valences are equalized. We must first reduce them to a common denominator (six). Take two of bismuth which makes a valence of six, and three oxygens with a valence of six; result, Bi_2O_3

II—Symbol

Definition

An abbreviation of an element, representing atomic weight and valence

Example

H represents hydrogen—weight 1, valence 1

Nomenclature

A—Subscript

Figure placed at lower right hand corner of symbol, applies only to symbol to which it is attached

Example

H_2O indicates two atoms of hydrogen and one atom of oxygen

B—Coefficient

Figure written before a symbol or formula applies to all atoms following

Example

$3H_2(SO_4)$ indicates that two hydrogens have been taken three times, and that the sulphate radicle has been taken three times

c—Table of Elements

	Symbol	Atomic weight
Aluminum	Al	27.04
Antimony	Sb	119.6
Arsenic	As	74.9
Barium	Ba	136.9
Bismuth	Bi	208.9
Boron	B	10.9
Bromin	Br	76.76
Cadmium	Cd	111.5
Caesium	Cs	132.7
Calcium	Ca	39.91
Carbon	C	11.97
Chlorin	Cl	35.37
Chromium	Cr	52.0
Cobalt	Co	58.18
Copper	Cu	63.18
Fluorin	F	19.0
Gold	Au	196.7
Helium	He	4.0
Hydrogen	H	1.0
Iodin	I	126.53
Iron	Fe	55.98
Lead	Pb	206.4
Lithium	Li	7.01
Magnesium	Mg	24.3
Manganese	Mn	54.8
Mercury	Hg	199.8
Molybdenum	Mo	95.9
Nickel	Ni	58.6
Nitrogen	N	14.01
Osmium	Os	190.3
Oxygen	O	15.96
Phosphorus	P	30.96
Platinum	Pt	194.3
Potassium	K	39.03
Silicon	Si	28.3
Silver	Ag	107.66
Sodium	Na	23.0
Strontium	Sr	87.5
Sulphur	S	31.98
Tin	Sn	118.8
Tungsten	W	183.6
Uranium	U	238.8

	Symbol	Atomic weight
Vanadium	V	51.1
Zinc	Zn	65.1

III—Acid

Definition

A compound with electro-negative element or residue united to hydrogen

a—Containing H

Example—HCl

b—Hydrogen of an acid can be replaced by a base to form a salt

Example—NaCl

c—Turns blue litmus paper, red

Classification

a—Monobasic acid, containing one replacable hydrogen

Example—HCl

b—Dibasic acid, having two replacable hydrogens

Example—H_2SO_4

c—Tribasic acid, having 3 replacable hydrogens

Example—$H_3(PO_4)$

Nomenclature of acids

A—Hydroacids—do not contain oxygen

Example—HCl (Hydrochloric acid)

B—Oxyacids, named according to acidic oxids

Example—$H(ClO_3)$ (Chloric acid)

C—Hypo—indicates less of negative element than *ous* acid

Example—HClO (Hypochlorous acid)

D—Hyper—indicates more of negative element than the ic acid

Example—$HClO_4$ (Hyperchloric acid)

E—Nitro—indicates presence of the (NO_3) radical

Example—HNO_3 (nitric acid)

F—Ous—indicates less of negative element than the ic acid

Example—$H(ClO_2)$ (Chlorous acid)

IV—Salts

Definition

Compound composed of positive element or radical united with negative element or radical

Formed

a—Union of metal and non metal

$K + Cl = KCl$

b—Union of basic oxid and acidic oxid

$CaO + CO_2 = CaCO_3$

c—Union of base and acid

$K(OH) + HCl = KCl + H_2O$

d—Action of metal on acid

$Cu + H_2(SO_4) = Cu(SO_4) + H_2$

e—Substitution of one radical for another

$KaCl + Ag(NO_3) =$
$K(NO_3) + AgCl$

Classification

A—According to replaced hydrogen

a—Normal salt—one in which all the hydrogen of acid is replaced

$H_2(CO_3) + 2NaCl = Na_2CO_3 + 2HCl$

b—Acid salt—one in which part of the hydrogen is replaced

$H_2CO_3 + NaCl =$
$NaHCO_3 + HCl$

c—A basic salt—a compound made up of a normal salt and the hydroxid or oxid of a metal

B—According to oxygen

a—Simple salt—a salt that does not contain oxygen

Example—NaCl

b—Oxysalt—a salt that contains oxygen

Example—$Cu(SO_4)$

C—According to bases:

a—Double salt—a salt in which the hydrogens of the acid are replaced by different metals

Example—Rochelle salt, $NaK\ (C_4H_4O_6)$

D—According to acids:

a—Monobasic salt—made by replacing one hydrogen of acid

NaCl

b—Dibasic salt—made by replacing two hydrogen of acid

$Na_2(SO_4)$

c—Tribasic salt—made by replacing three hydrogens of acid

$Na_3(PO_4)$

Nomenclature

Positive element is named first, then the negative element

a—Simple salts terminate in id

Example—Sodium Chlorid, NaCl

Prefixes are added to indicate number of positive and negative elements—

Proto

Combination of one positive and one negative element

Example—NaCl (proto-sodium chlorid)

Bi indicates one positive and 2 negative elements

Example—$HgCl_2$ (mercury bichlorid or bi-mercury chlorid)

Sub indicates two atoms of the positive element with one atom of the negative element

Example—Ag_2O (Suboxid of silver)

Sesqui indicates two atoms of positive with three atoms of negative element

Example—Fe_2O_3 (Iron sesquioxide)

Suffix

Ous indicates that compound contains less of electro-negative element than the *ic* compound contains

Example: HgCl (mercurous chlorid)

Ic indicates compound that contains more of electro-negative radical than *ous*

Example: $HgCl_2$ mercuric chlorid

Ic compounds are usually more stable

b—Oxysalts

1—End in *ite* when they are derived from an *ous* acid—Example:

$H_2(SO_3)$ (Sulphurous acid)

$Na_2(SO_3)$ (Sodium sulphite)

2—End in *ate* when they are derived from an *ic* acid

$H_2(SO_4)$ Sulphuric acid

$Na_2(SO_4)$ Sodium sulphate

V—Atom

Definition

The smallest particle of an element that can exist only in chemical combination

Method of determining atomic weight

By electrolysis

Acidified water is placed in an apparatus for electrolysis. The tubes containing the poles are graduated, and completely filled with water. Hydrogen and Oxygen are liberated at the poles, rise and force the water from the tubes. When a sufficient quantity of the gases has been formed, the electrolysis is checked

and the volume of each gas is read from the graduations. The volume of hydrogen is always twice that of the oxygen. The gas in each tube is now weighed, the oxygen weighing eight times as much as the hydrogen. As the volume of hydrogen is twice that of the oxygen, oxygen must weigh 16 times as much as an equal volume of hydrogen. According to the law of Avogadro, equal volumes of hydrogen and oxygen contain the same number of molecules, therefore oxygen is sixteen times as heavy as hydrogen. The atomic weight of oxygen is consequently sixteen

VI—Atomic weight

Atomic weight is the smallest quantity of an element (by weight) which is present in the molecule of any of its compounds or it is the specific gravity of an element in its gaseous state, compared with hydrogen. Exceptions: Hg, Cd, Helion and Argon; in these the atomic weight is twice the specific gravity. In Arsenic and Phosphorus the atomic weight is ½ the specific gravity

VII—Equivalent weight

Least amount of an element that will replace one part of H

Example—in water H_2O

Two parts of hydrogen will unite with sixteen parts of oxygen, hence one part of H will unite with eight parts of oxygen; hence eight is the equivalent weight of oxygen

VIII—Molecule

Definition

The smallest particle of matter that can exist alone

a—Molecular weight

Molecular weight is equal to twice the specific gravity in the gaseous state compared with hydrogen—or the sum of the atomic weights:

Example—$H_2(SO_4) = 98$

b—Molecular volume

The volume occupied by the number of grams, molecular equals to weight of a substance

Example—32 gms. of O = 22.32 liters

Example—18 gms. of H_2O = 22.32 liters

Example— 2 gms. of H = 22.32 liters

IX—An Element

A substance which cannot be further simplified

About 80 have thus far been recognized

Classified into

A—Metals

Solid opaque substances, peculiar metallic luster and taste, malleable, ductile and tenacious, conduct heat and electricity, combine with oxygen to form oxids, replace hydrogen of acids to form salts

B—Non-metals

Elements which do not have the above characters

X—Allotropism

The property possessed by certain elements of presenting themselves into two or more different forms

Example

Allotropic forms of carbon are diamond, graphite and charcoal

XI—Isomerism

Definition

Compounds which contain the same elements in the same proportion by weight but have different properties

Varieties

A—Metamerism

Substances are metameric when their molecules contain equal number of atoms of the same elements; for example—Cane sugar and milk sugar $C_{12}H_{22}O_{11}$ have the same composition but different physical properties

B—Polymerism

Definition

Substances are polymeric when they have the same centisimal composition but different molecular weight

Example

Acetylene C_2H_2

Benzene C_6H_6

or

Formaldehyd CH_2O

Acetic acid C_2H_4O

Lactic acid $C_3H_6O_3$

Glucose $C_6H_{12}O_6$

XII—Chemical Compound

A substance which can be divided into something simpler than itself

Example—H_2O can be broken up into oxygen and hydrogen

XIII—Formula

1—Representation of a compound by means of the symbols of the elements composing it

A—Empiric formula
Simplest expression of any compound as HO for water
B—Molecular formula
Indicates number of atoms in the molecule; H_2O for water
C—Rational formula
Expresses arrangement of elements in molecule H–OH for water
D—Graphic
Shows arrangement of elements by bonds H-O-H for water

2—Examples of chemical formulae

A—Mercuric chlorid (Corrosive sublimate) ..... $HgCl_2$
B—Blue vitriol ..... $CuSO_4$
C—Hydrogen peroxid ..... H_2O_2
D—Calcium hydrate (lime water) . $Ca(OH)_2$
E—Ammonium chlorid (Sal ammoniac) ..... NH_4Cl
F—Chili saltpeter ..... $NaNO_3$
G—Paris green (cupric aceto arsenite ..... $Cu(C_2H_3O_2)_2+3CuO_4As_2$
H—Mercurous chlorid (Calomel) .. $HgCl$
I—Sodium sulphate (Glauber's salt) ..... Na_2SO_4
J—Hydrogen sulphid ..... H_2S
K—Boric acid ..... H_3BO_3
L—Washing soda ..... $Na_2(CO_3)$
M—Hydrochloric acid (muriatic acid) ..... HCl
N—Nitric acid (aqua fortis) ..... HNO_3
O—Phosphoric acid ..... H_3PO_4
P—Suphuric acid (oil of vitriol) .. H_2SO_4
Q—Acetic acid ..... $H(C_2H_3O_2)$
R—Water ..... H_2O
S—Ammonia ..... NH_3
T—Marsh gas ..... CH_4
U—Calcium carbonate (marble or chalk) ..... $CaCO_3$
V—Copper nitrate ..... $Cu(NO_3)_2$
W—Ferric chlorid ..... $FeCl_3$
X—Sodium chlorid (table salt) ... $NaCl$

Y—Potassium iodid ..... KI
Z—Carbon dioxid ..... CO_2
AA—Gypsum (Plaster paris) ..... $CaSO_4$
BB—White vitriol ..... $ZnSO_4$
CC—Lunar caustic ..... $AgNO_3$
DD—Alum ..... $NH_4Al(SO_4)_2$
EE—Green vitriol ..... $FeSO_4$
FF—Caustic potash ..... KOH
GG—Rochelle salts ..... $NaK(C_4H_4O_6)$
HH—Baking soda ..... $NaHCO_3$
II—Sugar of lead (Lead acetate)... $Pb(C_2H_3O_2)_2$
JJ—Tartar emetic ..... $KSbO(C_4H_4O_6)_2$
KK—Aqua regia ..... $NOCl$
LL—Cream of tartar ..... $KH(C_4H_4O_6)$
MM—Verdigris (basic acetate of copper) ..... $Cu(C_2H_3O_2)_2CuO$
NN—Milk of lime..... $Ca(OH)_2+H_2O$
OO—Copperas (green vitriol) ..... $FeSO_4$
PP—White lead ..... $Pb(CO_3)_2+Pb(OH)_2$
QQ—Quick lime ..... CaO
RR—Epsom salts ..... $Mg(SO_4)$
SS—Caustic soda ..... $Na(OH)$
TT—Salt peter ..... $K(NO_3)$

Laws Governing Chemical Combination

A—Same compounds always contain same elements in same proportion

B—Law of multiple proportion

When two elements unite with each other to form more than one compound, the resultant compound contains the simple multiple proportion of one element as compared with a constant quantity of the other; *i. e.*

N_2O nitrogen monoxid
N_2O_2 nitrogen dioxid
N_2O_3 nitrogen trioxid
N_2O_4 nitrogen tetraoxid
N_2O_5 nitrogen pentoxid

C—Law of Equivalent or Reciprocal Proportion

The weights of different elements which combine separately with one and the same weight of another element, are either the same, or are simple multiples of the weights of the respective elements which combine with each other, *i. e.*

1 part of H unites with 35.5 parts of Cl

1 part of H unites with 8 parts of weight of O
Cl therefore unites with oxygen in the proportion of 35.5 to 8, by weight

D—Law of Gaseous Volume

When chemical action takes place between gases, the volume of the gaseous product bears a simple relation to the volume of the reacting gases

H, 11.16 liters unites with Cl, 11.16 liters, to form HCl, 22.32 liters

E—Periodic law of Mendelejeff

The properties of elements, the constitution of their compounds and the properties of these latter, are periodic functions of the atomic weights of the elements

Equation

A—Definition

Abbreviation of a chemical change

B—Method

On left is written the substances used to start the reaction; on the right is placed the formula of the new substances produced. The sum of the weights on one side must equal the sum of the weights on the other side

Example—$CuO + H_2(SO_4) = CuSO_4 + H_2O$

C—Philosophy

Equal valences always unite; the valence of H is one, hence Cl is one because it unites with one hydrogen to form HCl. The valence of O is two because it takes two hydrogens to unite with it to form H_2O. In writing equations it is most important that valences be considered

To write an equation, first obtain the valences, reduce the valences to a common denominator, then unite the positive with the negative elements

Example—$CuO + H_2(SO_4) =$

Valence of Cu is 2; it unites with oxygen (valence 2, because oxygen unites with 2 atoms of hydrogen to form water). The valence of the sulphate radical is 2 because it requires 2 hydrogens to unite with it. Elements and radicals having a valence of 2, it is unnecessary to reduce to a common denominator. The first element in a compound is always positive, the second is negative; hence—

$CuO + H_2(SO_4) =$

$$+ - \quad + \quad -$$

unite positive and negative result is

$$Cu(SO_4) + H_2O$$

Again

$$Na_2(SO_4) + BiCl_3 =$$

2 sodiums carry a valence of 2; the sulphate radical therefore is two; the valence of bismuth is 3 because it takes 3 chlorins to unite with it. Bismuth (valence of 3) cannot be united with the sulphate radical (valence of 2) hence it is necessary to reduce them to a common denominator. Result—

$$3Na_2(SO_4) + 2BiCl_3 =$$

$$+ \quad - \quad + \quad -$$

$$6NaCl + Bi_2\ (SO_4)_3$$

Again

$$H_2(SO_4) + NaCl =$$

$$+ \quad - \quad + \quad -$$

Here one hydrogen unites with one chlorin to form HCl and sodium combines with the sulphate radical to form an acid salt. Result:

$$NaH(SO_4) + HCl$$

Definitions

A—Physical change

A change in which substances do not lose their identity

Example—Water changing into ice

B—Chemical change

A change in which substances lose their identity

Example—Wood when burned is decomposed into CO_2 and H_2O

C—Base

A base is an oxid or hydroxid of a metal having electro-positive properties; neutralizes acids forming a salt and water. Bases emulsify fats and change red litmus to blue

Example—$K\ (OH) + HCl =$

$$KCl + H_2O$$

D—Nascent state

The state of an element just before combination

E—Radical

Group of elements that act like one

Example—$(NO_3)\ (SO_4)\ (PO_4)$

A—Basic radical has

Positive properties (NH_3)

B—Acid radical has
Negative properties (SO_4)

F—Anhydrid
Oxid capable of combining with elements of H_2O to form an oxacid (oxy acid)
Example—$CO_2 + H_2O = H_2CO_3$

G—Combustion
Rapid oxidation with the evolution of heat and light

H—Decomposition
Separation of a compound into two or more dissimilar substances
Example—$Ca(CO_3) = CaO + CO_2$

I—Dissociation
Separation of a compound into its ions
Example—NaCl by electrolysis breaks up into ions of Na and Cl

J—Alloy
A mixture of two or more metals, *e. g.*, Cu and Zn to form brass

K—Amalgam
An alloy containing mercury; *e. g.*, tin and mercury

L—Analytic chemistry
Methods for splitting compounds into simpler parts
Example—H_2O can be split by an electric current into H and O

M—Synthetic chemistry
Methods for building simpler substances into complex compounds
Example—CO_2 and water produce carbonic acid

N—Reducing and oxidizing agents
Removal of oxygen from a compound is called reduction. Agents which do this are called reducing agents. Adding oxygen is called oxidation. Agents causing change are called oxidizing agents. Example: reducing agent; Fe will take O from the air; result, Fe_2O_3. Example of an oxidizing agent: Hydrogen peroxid when exposed to the air will break up into $H_2O + O$

O—Binary compound
Contains two elements

P—Ternary compound
Contains three elements

Q—Hydrid

Binary compound containing hydrogen
Example—LiH (Lithium Hydrid)
B—Hydroxid
Compound of hydroxul combined with base
Example—KOH (Potassium hydroxid)

INORGANIC CHEMISTRY

NON-METALS

Hydrogen

Occurrence
Free in volcanic gases; forms ⅑ of water; 10% of body weight

Mode of preparation
A—Decomposition of H_2O by electrolysis
B—Treat a metal with mineral acids
$Zn + H_2SO_4 =$
$ZnSO_4 + H_2$

Physical properties
Colorless, odorless and tasteless gas; lightest known substance combustible, producing much heat; liquefies under pressure; conducts heat and electricity better than other gases; all hydrates contain H and O

Chemical properties
Symbol .....H
Valence 1
Atomic weight 1
Molecular weight 2
Reducing agent—takes O from other substances
$CuO + 2H = H_2O + Cu$

Compounds
A—HBr—hydrobromic acid
B—HI—hydroiodic acid
C—H_2S—hydrogen sulphid
D—H_3As—arsenated hydrogen
E—NH_3—ammonia
F—Water H_2O—water, H_2 (22,320) and O (11,160)
Occurrence
Exists as liquid, gas, solid; 75% of body is H_2O
Physical properties of a good drinking water
A—Clear and limpid
B—Colorless; a greenish or yellowish color due to vegetable or animal matter in suspension or to organisms

C—Odorless; especially must be free from sulphurated hydrogen or putrefactive animal matter

D—Temperature from 46 to 60 degrees F.

E—Agreeable taste, neither flat, salty, nor sweetish; a certain amount of hardness and dissolved gases give a sparkling taste. It should contain from 25 to 50 cc. of gases per liter, of which 8 to 10 per cent. is carbon dioxid and the rest oxygen and nitrogen

F—Free as possible from dissolved organic matter, especially of animal origin

G—Should not contain too great amount of hardness. A certain quantity of saline matter is necessary however to give it a good taste. It should not contain over three or four parts of chlorin in 100,000 parts of water

H—Becomes solid at 32 deg. F., vaporized at 212 deg. F.; greatest density at 4 deg. C. Substances dissolved in water lower its freezing point and raise its boiling point. Water is an exception to the law of expansion by heat.

Classification

A—Mineral content

a—Hard water

Holding in solution mineral salts decomposes soap, precipitates albumen, neutralizes HCl and produces intestinal derangement. May be rendered soft by boiling

b—Soft water

Holding in solution little or no minerals

B—Medicinal

a—Chalybeate, containing iron

b—Sulphur—containing sulphur

c—Bitter—containing $MgSO_4$ and Na_2SO_4

d—Effervescent—containing CO_2

e—Cathartic—containing $Mg(SO_4)$

f—Saline, same as cathartic

g—Alkaline, containing carbonates

C—Source

a—Rain water; good after first rainfall

b—Well water; filtered rain water; quality depends on strata traversed

c—River water, not so good; polluted from bank

d—Lake water, good when lake is large and when water is taken far from shore

Standards based on water

Weight

1 cc. of water at 4 degrees C. weighs one gram

Temperature

Centigrade thermometer is zero at the freezing point of water, 100 degrees at the boiling point. Fahrenheit has correspondingly 32 degrees and 212 degrees

Heat

A heat unit is called a calorie. It is the amount of heat required to raise 1 gram of water 1 degree centigrade. In Europe: the amount of heat needed to raise one kilogram of water 1 degree centigrade

Specific gravity

Water is the unit of comparison for solids and liquids

Test for Organic Impurities

a—Test tube containing suspected water: add potassium permanganate; if organic material is present, the $KMnO_4$ loses its color

b—Test for Sewage contamination

1—Determine the quantity of chlorid present by means of a standard solution of silver nitrate, using potassium chromate as an indicator

c—Detecting lead in water

1—Add a drop or two of ammonium sulphid; a black percipitate (PbS) is formed

D—H_2O_2 hydrogen peroxid

Source

$BaO_2 + H_2SO_4 + BaSO_4 + H_2O_2$

Physical properties

Colorless, oily liquid, soluble in H_2O and alcohol; metallic taste; possess antiseptic, caustic and bleaching power; deodorant; 14 volume solution is one that yields 14 volumes of O for 1 volume of H_2O_2

Test

Paper moistened with KI and starch is colored blue due to liberation of iodin: $2KI + H_2O_2 = 2KOH + 2I$

OXYGEN

1—Symbol ..... O
2—Atomic weight 16
3—Molecular weight 32

4—Atomic volume .....11.16 liters
5—Molecular volume .....22.32 liters
6—Density 1.1056
7—Occurrence

Most abundant element: composes 20% of atmosphere; forms eight-ninths part by weight of H_2O occurs as oxids, oxyacids and oxysalts and is present in almost all animal and vegetable compounds; one-half of the crust of the earth is composed of oxygen; it forms 66% of body weight

8—Physical properties

It is colorless, odorless and tasteless gas, a supporter of combustion, but non-combustible. It may be liquefied and solidified under certain conditions

9—Chemical properties

Powerful electro-negative (anionic) element, uniting with all elements except fluorin, bromin and the helium group.
Oxids—Substances that contain one element in combination with oxygen. Example—PbO (Lead oxide)
Removal of oxygen from a compound is known as a reduction, adding oxygen to any compound as oxidation. Agents causing the former are called reducing agents; those causing the latter are called oxidizing agents

10—Preparation

A—BaO_2 heated gives $BaO + O$
B—O is produced by heating manganese dioxid with sulphuric acid. $2MnO_2 + 2H_2SO_4 = 2MnSO_4 + 2H_2O + O_2$
C—Heating manganese dioxid with potassium chlorate $2KClO_3 + 2MnO_2 = 2MnO_2 + 2KCl + 3O_2$
D—Heating mercuric oxid
$2HgO + Heat = Hg_2 + O_2$

11—Ozone

Symbol .....O_3
Molecular weight 48
Production

Passing electric sparks through oxygen

Physical properties

An allotropic form of oxygen; colorless gas, having an odor resembling that of chlorin; irritating to mucous membranes, producing headache; oxidizing agent destroying organic matter; can be condensed into a blue liquid

Occurrence

Ozone is found in the air in small quantities. Abundant in the air of pine forests due to the oxidation of the turpentine

Uses

Commercially to bleach oils; to purify starch; also, to sterilize drinking water. It will remove color from organic dyes

NITROGEN

Symbol ..... N
Atomic weight 14
Valence 3

Properties

Colorless, odorless, tasteless gas; neither combustible nor a supporter of combustion and slightly lighter than air. Its compounds are unstable, decomposing with explosive violence. It is not poisonous.

Preparations

$NH_4Cl + KNO_2 = KCl + 2H_2O + 2N$

Oxids of Nitrogen

A—N_2O hyponitrous oxid (nitrous-oxid), nitrogen monoxid, laughing gas, formed by heating ammonium nitrate and collecting the gas $NH_4(NO_3) = N_2O + 2H_2O$. A colorless, odorless gas, of sweet taste

B—N_2O_2 nitrogen dioxid

C—N_2O_3 (nitrogen trioxid) acid formed equals HNO_2

D—N_2O_4 nitrogen tetroxid (nitrogen peroxid)

E—N_2O_5 nitric oxid (nitrogen pentoxid) acid formed equals HNO_3

Air—Gas which encircles the earth; a mixture, not a chemical compound

Constituents of the atmosphere....Volume

Nitrogen 77%
Oxygen 21%
Water Vapor ..... Trace
Carbon Dioxid 0.05%

Helium Group ..
1—Argon
2—Helium
3—Xenon
4—Neon
5—Krypton 0.93%

Traces .....
1—Ammonia
2—Ozone
3—Nitric acid
4—Sulphuric acid
5—Hydrogen sulphid

Test for CO_2

Expose a measured volume of the air to a definite volume of lime-water of an alkaline strength, previously determined by means of a deci-normal oxalic acid solution. When all the carbon dioxid has combined with the lime water, the alkalinity of the solution is again determined by means of the oxalic acid solution. The difference between the alkalinity before and after the addition of the air, indicates the quantity of lime-water necessary to remove the carbon dioxid present in the volume of air acted upon

$$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O$$

Compounds

A—Ammonia NH_3

B—Ammonium NH_4—Hypothetic electropositive base

C—Nitric acid (Aqua fortis) HNO_3

D—Ammonium chlorid (Sal ammonia) NH_4Cl

SILICON

Symbol ..... **Si**

Atomic weight **28**

Occurrence

In combination, not free in nature; most abundant element next to oxygen; found in quartz, clays or slate

Preparations

$$K_2Si + F_6 + 4K = 6KF + Si$$

Physical Description

Dark brown powder or in needle-shaped crystals

Preparation

A—Silicon dioxid SiO_2

B—Silicic acid H_4SiO_4

C—Carborundum C Si (Silicid of carbon)

CARBON

Symbol C

Valence 4

Atomic weight 12

Molecular weight 24

Physical and Chemical properties

Carbon is a solid, always black except in the form of diamond; devoid of taste and color, insoluble in all known liquids; combustible, yielding CO_2. It is the transitional element which unites the three natural kingdoms. It enters into combination with many elements, producing very important compounds, as CN, HCN, CO, CH_4

Various Allotropic forms of carbon

A—Diamond

B—Graphite

Bluish black friable substance, metallic luster, greasy feeling, dark line when drawn across paper, used in pencils and stove polish

C—Charcoal

Compounds

A—Carbon monoxid

Formulae .....CO

Properties

Unites with hemoglobin to form carbon monoxid hemoglobin, which is a very stable compound and will prevent the combination of hemoglobin with oxygen.

B—HCN—Hydrocyanic acid

C—CO_2—Carbon dioxid

D—CS_2—Carbon disulphid

E—$H_2(CO_3)$ Carbonic acid

F—$COCl_2$ Carbonyl chlorid

G—CN_2—Cynaogen

Colorless gas, odor of peach kernels, burns with purple flame, combines with hydrogen forming hydrocyanic acid (prussic acid)

Compounds

1—Potassium cyanid KCN

2—Hydrocyanic acid HCN

SULPHUR

Symbol ..... S

Valence 2–4–6

Atomic weight 32

Allotropic Forms

A—Prismatic

B—Rhombic

C—Plastic

D—White

E—Octahedral

Occurrence free in nature and in combination with sulphids and sulphates in volcanic districts

Properties

Sulphur is a yellow, odorless, tasteless, brittle, crystalline solid; insoluble in water, soluble in carbon disulphid, chloroform, and fixed oils. It is an electro-negative element. Sulphur as a germicide acts only when in the form

of H_2SO_3 acid; action is due to dehydration and deoxidation of the germs. It is objectionable because of its bleaching action. Sulphur sublimatum (flowers of sulphur) formed by subliming the crude element. Sulphur lotum is sulphur washed in water to free it from sulphuric acid. Sulphur precipitatum: dissolve sulphur in water with lime and precipitating with HCl

Compounds

A—H_2S: Hydrogen sulphid

A colorless gas, smells like putrid eggs; a narcotic, has acid properties. Is a reagent in the laboratory, precipitates many metals from their solutions. Inhaled it produces nausea, headache and dizziness.

B—SO_2 Sulphur dioxid

C—H_2SO_4 Sulphuric acid

A colorless, oily liquid, intensely acid, chars organic matter, has great affinity for water, forms sulphates with metallic oxid. Formerly made by distilling green vitriol; hence the name of Oil of Vitriol. Contains a large per cent. of O, hence is a good oxidizing agent. Test with barium chlorid forms white precipitate of insoluble barium sulphate. Salts of sulphuric acid are called sulphates

D—PbS Lead sulphid

E—$CaSO_4$ Calcium sulphate

F—$MgSO_4$ Magnesium sulphate

G—Na_2SO_4 Sodium sulphate

H—$BaSO_4$ Barium sulphate

PHOSPHORUS

Symbol ..... P

Atomic weight 31

Valence 1–3–5

Molecular weight 124

Allotropic forms of phosphorus

A—Yellow

B—Red—not poisonous

C—White

D—Black

Properties

It is a translucent, yellowish, wax-like solid stick with a garlicky odor; sparingly soluble in water, but freely in carbon disulphid and certain oils. Spontaneously inflammable in air and is highly toxic. It emits light in the dark,

readily combining with oxygen to form oxids and with chlorin and other elements. Uses; in alloys, as a tonic, and reconstructive, and as a bone producer. Occurs in nature, in phosphates, in structure of plants and animals. Amorphous phosphorus is formed by heating phosphorus in atmosphere free from oxygen; an odorless nontoxic nonluminous dark red powder.

Compounds

Hypophosphorous oxid, $P_2O + 3H_2O = 2H_3PO_2$ Hypophosphorous acid

Phosphorous oxid, $P_2O_3 + 3H_2O = 2H_3PO_3$ Phosphorus acid

Phosphoric oxid $P_2O_5 + 3H_2O = 2H_3PO_4$ Phosphoric acid

$P_2O_5 +$

$H_2O = HPO_3$ Meta phosphoric acid

$2H_2O = H_4P_2O_7$ Pyrophosphoric acid

$3H_2O = H_3PO_3$ Orthophosphoric acid

HALOGENS (Sea Salt Producers)

1—Chlorin

2—Bromin

3—Fluorin

4—Iodin

General Properties

All univalent, anionic, form compounds with valence of 1–3–5 or 7; combine with hydrogen to form HI, HCl, HBr, HF, all colorless gases, soluble in water, combine with metals to form fluorids, chlorids, bromids and iodids. Relative combining power diminishes as atomic weight increases.

Fl—Atomic weight....19 greatest combining power

Cl—Atomic weight....35

Br—Atomic weight....80

I —Atomic weight...126 least combining power

All possess bleaching and disinfecting power

Chlorin

Symbol Cl

Atomic weight 35.5

Chlorin is a greenish gas; condenses into a yellowish liquid; very irritating to the mucous membrane; suffocating poison, soluble in water; a bleaching and disinfecting agent. With hydrogen it forms hydrochloric acid; with

metals, salts called chlorids. An electro-negative monad element. Occurs in sea water and in rock salt.

Compounds

A—HCl—Hydrochloric acid, made by action of sulphuric acid on sodium chlorid:

$2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl$

Properties

HCl is a gas very soluble in water. When pure it is colorless; is the only known compound of chlorin and hydrogen.

B—NOCl—Nitro hydrochloric acid ("Aqua Regia"), a mixture of hydrochloric acid and nitric acid. They unite, liberating chlorin

$HNO_3 + 3HCl = 2H_2O + NOCl + Cl_2$

C—Acids

$HClO_3$ Chloric acid
$HClO_4$ Hyperchloric acid
$HClO_2$ Chlorus acid
HClO Hypochlorous acid

D—Chlorinated lime

Made by passing Cl gas over slaked lime

$Ca(OH)_2 + Cl_2 = CaClOCl + H_2O$

BROMIN

Symbol .....Br
Atomic weight 80

Preparation

$MgBr_2 + 2Cl = MgCl_2 + 2Br$

Heavy, dark reddish brown liquid giving off yellowish red fumes, only liquid element besides mercury; found in salt wells.

Detection

Identified by its color and odor

Bromin water shaken with chloroform gives a brownish layer—Starch water gives a deep yellow color

IODIN

Symbol I
Atomic weight 126

Occurrence

Occurs in sea-weeds and in sea water as iodids and inorganic compounds

Physical properties

Bluish black crystalline substance; metallic luster, distinctive odor, acid taste, neutral reaction, violet vapor; when heated with starch, produces blue color.

Compounds

A—Iodid of potassium .....KI
B—Sodium iodid .....NaI
C—Ammonium iodid .....NH_4I
D—Mercurous iodid .....HgI
E—Mercuric iodid .....HgI_2

FLUORIN

Symbol .....F or Fl
Atomic weight 19
Description

Yellowish gas, irritating and suffocating odor, supporter of combustion, great affinities for all elements; only element not combining with oxygen

Occurrence

Occurs in nature in fluorspar; used for etching on glass; stored in gutta-percha bottles

METALS

Definition

Solid, opaque substance, peculiar metallic luster and taste, malleable, ductile and tenacious, conducts heat and electricity, combines with O to form oxids, replaces H of acids to form salts. Electropositive; unites with metals to form alloys; oxid of non-metals unite with water to form acids, oxid of metals unite with water to form bases. They seek the negative poles called anions.

Note

The student is expected to memorize the general properties of metals and apply them to the subsequent metals, noting the exceptional features.

Valence

Univalent

Li
K
Na
Ag

Bivalent

Ba
Ca
Sr
Mg
Zn
Cu
Hg

Trivalent
Al
Bi-quadri-valent
Ni
Co
Pt
Sn
Bi, quadri or sex-valent
Fe
Mn
Mo
Tri and quin-valent
Sb
As
Bi
Uni and Trivalent
Au

Common characteristics

About one-half these fifty-eight elements are of practical importance and the remainder, occurring in small quantity, of scientific interest only. Their general properties have been mentioned

Physical properties

All are solid at ordinary temperatures except mercury (a liquid). All are fusible and some volatile. Iron best electro magnet, silver best electro conductor, radium rarest metal, osmium most infusible element

Chemical properties

All combine with fluorin, chlorin and oxygen; some with sulphur, bromin and iodin, and a few with carbon and phosphorus, forming fluorids, chlorids, oxids, sulphids, bromids, iodids, carbids and phosphids, respectively. Metals form salts by replacing the hydrogen in acids

Occurrence

A few occur in nature in a free state; the majority in combination as oxids, sulphids, carbonates, silicates, sulphates and chlorids

Preparation

A—By heating the oxids with charcoal, the carbon combines with oxygen and the metal is liberated

$$FeO + C = CO + Fe$$

B—The sulphids are converted into sulphates or oxids by roasting, *i. e.*, by heating to a high degree in an oxidizing atmosphere

C—By electrolysis of their ores

Classification

Groups may be variously made. Depending on their analytical peculiarities, metals are divided into two classes and six groups

a—Light metals

1—Specific gravity 4–6

2—Sulphids soluble in water

A—Earth metals

Aluminum and some rare metals

Oxids insoluble

B—Alkali metals

Potassium

Sodium

Lithium

Rubidium

All salts soluble in mineral acids

C—Alkaline earth metals

Calcium

Barium

Strontium

Magnesium

Oxids soluble

Carbonates insoluble

b—Heavy metals

1—Specific gravity 6–21

2—Sulphids insoluble

A—Arsenic group

Arsenic

Antimony

Tin

Gold

Platinum

Molybdenum

Sulphids insoluble in dilute acids, soluble in ammonium sulphid

B—Lead group

Lead

Copper

Bismuth

Silver

Mercury

Cadmium

Sulphids insoluble in dilute acids and in ammonium sulphid

C—Iron group
Iron
Manganese
Zinc
Chromium
Cobalt
Nickel
Sulphates soluble in dilute acids

EARTH METALS

Aluminum
Symbol .....Al
Atomic weight 27
Occurrence
In great abundance, found in all rocks
Preparation
Aluminum oxid when fused produces aluminum
Description
Bluish white silvery malleable light metal not acted upon by air
Compounds
Ammonium alum
$NH_4Al(SO_4)_2$
Aluminum potassium alum
$AlK(SO_4)_2$

ALKALI METALS

General properties
All univalent, decompose water with liberation of hydrogen, combine with oxygen and chlorin salts, soluble in H_2O
Soft metals of silvery, white color because of their tendency to combine with oxygen; must be kept under a liquid like coal oil; lithium lightest known solid

Potassium
Symbol ..... K
Atomic weight 39
Found
In its compounds only
Source
Saltpeter, rocks, ashes of plants, sea water
Prepared
$K_2CO_3 + 2C = 2K + 3CO$
Properties
Shows silver white luster; soft like wax, plastic, tarnishes

in air. Thrown upon water liberates H; burns with purple flame. Combines with non-metals evolving heat and light. Useful as a reducing agent in the laboratory

Compounds

KOH ..... Caustic potash
K_2O ..... Potassium oxid
K_2CO_3 ..... Potassium carbonate
KNO_3 ..... Saltpeter
$KClO_3$ ..... Potassium chlorate
KI ..... Potassium iodid
$KMnO_4$ ..... Potassium permanganate

Test for Potassium salts

Add tartaric acid: white precipitate of bitartarate. On burning over a Bunsen burner, a reddish violet color is seen when viewed through cobalt blue glass

SODIUM

Symbol ..... Na
Atomic weight 23

Source

In salt beds. So active that if liberated it unites at once with other elements, found also as a constituent of many rocks and of plants growing near the sea waters

Preparation

By evaporating brine to get common salt; or, by distillation of the carbonate when heated with carbon: $Na_2CO_3 + 2C = Na_2 + 3CO$

Properties

Soft plastic solid, silver white, tarnishes in air. It decomposes water and ignites the hydrogen. To protect sodium from O of the air, it is kept under petroleum. The hydroxid dissolves in water

Compounds

NaCl ..... Sodium chlorid
Na (OH) ..... Sodium hydroxid
Na_2SO_4 ..... Glauber's salt
Na_2CO_3 ..... Washing soda

STRONTIUM

Symbol ..... Sr
Atomic weight 87.5

Occurs

As sulphate and carbonate

Preparation and properties

By electrolysis of the fused chlorid. A yellow malleable

metal, oxidizing quickly in air. Burns when heated with a red flame and decomposes water

MAGNESIUM

Symbol .....Mg

Atomic weight 24

Occurs

In large quantities, widely distributed. Found in talcum, soapstone and asbestos

Prepared

By electrolysis of fused magnesium chlorid and by reducing with metallic sodium:

$$MgCl_2 + 2Na = 2NaCl + Mg$$

Properties

Bluish white tough metal; stays untarnished in dry air. Evolves hydrogen in boiling water. Burns in air with an intense white flame. Dissolves easily in dilute acids

RADIUM (From Radium or Ray)

Symbol .....Ra

Atomic weight 226.5

Occurs

In most minute quantities in pitchblende. Ra is a hypothetical metal. Found in Colorado and Bohemia

Preparation

The metal itself has not been isolated. Fractional crystallization of 2000 pounds of pitchblende yields ½ gr. radium chlorid. Free radium would oxidize quickly. Radium gives off three kinds of rays, known as Alpha, Beta, Gamma. These are ionic, cathodal and ethereal respectively

Alpha Rays

Are ions double the mass of H atoms. They are projected with great velocity, can be deflected by the magnet, are positive and have little penetrating power

Beta Rays

Are flying corpuscles, *i. e.*, electrons. They are 1/1000 the weight of a H atom, affect photographic plates

Gamma Rays

Move in straight paths, resembling waves in ether. They are neutral electrically, are not deflected by the magnet and penetrate opaque objects

Radium Compounds

Affect photographic plate through sheets of paper or metal. They bring about also chemical changes in substances, placed near them. Helium seems to be formed when radium decomposes

IRON GROUP

General Properties

Form sulphids insoluble in water but soluble in dilute mineral acids; magnetic (zinc exception), decompose water, with an oxid formed and H liberated; bivalent or quadrivalent, in some cases trivalent or sexvalent

IRON

Symbol .....Fe
Atomic weight 56

Occurs

Next to aluminum, the most abundant in the earth's crust. The most common ores are the oxids, carbonates, sulphites (iron pyrites)

Properties

A silver white, tenacious metal. In moist air forms rust of oxid and hydrate; oxidizes at red heat and decomposes water, forming H and the black oxid of iron; best electromagnet, freely soluble in dilute sulphuric and hydrochloric acids. Forms ferrous and ferric compounds. Ions of the former are bivalent, ions of the latter are trivalent.

Cast Iron

Is the product of the blast furnace. White cast iron is the product of rapid cooling in which the carbon remains in chemical combination. Gray iron is the product of slow cooling; the carbon in this case is partially separated in flakes of graphite. Cast iron is strong but not elastic. It is used for making castings.

Wrought Iron

This is made by burning out most of the carbon silicon, phosphorus, and sulphur from the cast iron.

Steel

Steel is made like wrought iron.

MANGANESE

Symbol .....Mn

Atomic weight 55

Occurs

In nature as an oxid MnO_2, abundant in many rocks, minerals, and the ashes of plants; also as the carbonate, $MnCO_3$

Prepared

From the carbonate or oxid by reduction; or by electrolysis of the chlorid

Properties

Physical and chemical properties resemble iron; red, hard, brittle. It is soluble in dilute sulphuric acid. Oxidizes easily, slightly magnetic. It is used commercially as an alloy of iron and bronze.

ZINC

Symbol .....Zn

Atomic weight 65.4

Occurs

In many minerals, principally as the sulphid carbonate and silicate.

Preparation

The ores are roasted, then heated with coke or charcoal. The oxid is reduced to the metallic state and the zinc volatilized

Commercial Zinc

Often contains arsenic, iron, and carbon as impurities.

Properties

White soft metal, tarnishes in air, volatilizes, soluble in acids and strong alkalis. Heated, it softens and can be rolled into sheets. Galvanized iron is iron covered with a layer of zinc. German silver contains copper, zinc and nickel. Brass contains copper and zinc. The ion of zinc is bivalent.

NICKEL

Symbol .....Ni

Atomic weight 58.6

Occurs

Abundantly in minerals

Preparation and Properties

Prepared from its oxid by heating. A white malleable solid, high melting point. Strongly magnetic.

Uses as an alloy

With copper forms coin metal; with copper and zinc forms

German silver; small amounts added to steel form what is known as nickel steel. In nickel plating it is deposited upon the surfaces of other metals and protects them from rust and it takes a high polish. Nickel is not acted upon by moist air. Its salts are usually green.

ARSENIC GROUP

Arsenic

Symbol ..... As
Atomic weight 75
Molecular weight 300
Valence 3–5

Properties

Arsenic is a steel black non-metal with a metallic appearance, lying on the border line of metals and non-metals; very brittle, unoxidized in dry air, but when heated in oxygen burns with a bluish white flame and produces arsenious oxid, odor of garlic. It is electronegative in character, combines with hydrogen and metals to form arsenids and with oxygen to form oxids. Its soluble salts are very toxic

Found

In nature combined as sulphids

Preparation

$2As_2O_3 + 3C = 4As + 3CO_2$

Antidote for Arsenic

Ferric hydroxidum cum magnesii oxido. The ferrous arsenate is insoluble, therefore non-poisonous. Antidote may be rapidly prepared. By mixing a dilute solution of iron sulphate or ferric chlorid with magnesium oxid and water and thoroughly shaking, the entire mass is given at once

Reaction

The ferric sulphate magnesium oxid and water make ferric hydroxid (which is the antidote for arsenic)

$Fe(SO_4)_3 + 3MgO + 3H_2O = 3MgSO_4 + Fe_2(OH)_6$

This latter (ferric hydroxid) acts as follows

$As_2O_3 + 2Fe_2(OH)_6 = Fe(OH)_2 + 5H_2O + Fe_3(AsO_4)_2$

Tests

Reinsch's

Acidulate suspected contents in test tube with HCl. Put a piece of bright copper foil in tube and heat; a

deposit forms on copper, remove, dry, put in another tube, and heat

If it is

1—Arsenic

Octahedral crystals form on cool part of tube

2—Antimony

Amorphous deposit

3—Mercury

Globules of mercury

Marsh's

Manufacture hydrogen by treating Zn with H_2SO_4, add suspected material; a black deposit forms on porcelain plate which is either arsenic or antimony

To differentiate

Arsenic

A—Volatilizes readily in an atmosphere of hydrogen

B—Escaping gas has the odor of garlic

C—When heated in a current of oxygen, octahedral crystals are formed

D—Arsenic dissolves promptly in a solution of sodium hypochlorite

Antimony

A—Requires a much higher temperature for its volatilization

B—The escaping gas has not the odor of garlic

C—When heated in a current of oxygen, an amorphous powder is formed

D—Antimony is insoluble in a solution of sodium hypochlorite

Antimony

Symbol ..... Sb (Stibium)

Atomic weight 120

Occurs

As metallic antimony in nature

Preparation

Melt stibnite with iron. The latter combines with the S and forms a slag, while the antimony being heavier falls to the bottom and is drawn off

$$Sb_2S_3 + 3Fe = 2Sb + 3FeS$$

Properties

Gray-white solid, crystalline, metallic appearance, hard and brittle. Its vapor burns to white fumes of Sb_2O_3

Does not oxidize in air. Soluble in HCl

Uses

Its small resistance to electricity is calling for its use in electrical construction

Compounds

Tartar Emetic

$KSbO(C_4H_4O_6)_2$

Properties

A white crystalline powder, acrid metallic taste, soluble in water, insoluble in alcohol. In vinum antimonii the water in the wine is the solvent

Gold

Symbol ..... Au

Atomic weight 196.7

Occurs

Free in nature; native gold is usually alloyed with silver

Obtained

From river sand by washing; from auriferous earth by hydraulic mining; by treating the ore with potassium cyanid and dissolving out the gold as a double cyanid potassium auricyanid. Zinc or electrolysis will set the gold free from the other elements. The amalagamation process consists in washing the gold over copper plates whose surfaces have been amalgamated with mercury

The gold adheres to the mercury and is then scraped off with it and the mixture distilled

Properties

Soft metal, orange yellow, very malleable. Unaffected by air and water. Can be hammered into thin translucent foil. Is soluble in strong nitro-muriatic acid. It is alloyed for use with silver and copper, U. S. Gold coin is 90% gold with 10% alloy of copper and silver; gold forms an amalgam with mercury. Soluble gold salts are trivalent. Aurous and auric compounds are formed

Platinum

Symbol ..... Pt

Atomic weight 195

Occurs

In small quantities in many localities

Prepared

By complicated refining process

Properties

A steel-white metal, high specific gravity, malleable, ductile,

insoluble in all acids except nitro-muriatic. Melts with difficulty. Alloys with molten metals. Air has no effect upon it. Used to make chemical utensils needed to withstand high temperature or strong reagents. Also for the wires sealed in incandescent light bulbs.

Compounds

Ions are bivalent and quadrivalent

a—Oxids

Platinum forms two oxids, monoxid PtO: and dioxid PtO_2

b—Chlorids

Platinum bichlorid $PtCl_2$, Tetrachlorid $PtCl_4$

c—Other salts

Bromids, iodids, ammoniacal compounds

Tests

Hydrogen sulphid forms a dark brown precipitate insoluble in HCl. Zinc precipitates metallic platinum

Tin

Symbol ..... Sn (Stannum)

Atomic weight 119

Occurs

As dioxid in tin-stone

Prepared

By roasting the ore with carbon

$SnO_2 + C = Sn + CO_2$

Properties

A silver white metal, soft, easily beaten into foil. Does not tarnish in air. Nitric acid forms an insoluble dioxid. Solder, bronze, pewter, type metal, gun metal are tin alloys

Tin Plate

Sheets of iron coated with thin layers of tin

Tin foil

Thin leaves of tin containing lead

Tin forms two classes of salts

a—Stannous-bivalent

b—Stannic-quadrivalent

LEAD GROUP

Lead

Symbol ..... Pb

Atomic weight 206.9

Occurs

In many minerals, principally galena (PbS); also as a

carbonate sulphate and chromate. The lead of commerce is made from galena

Preparation

Roasting and precipitating reduces the sulphid with metallic iron $PbS + Fe = Pb + FeS$

Properties

Soft, bluish white metal, malleable; low melting point, tarnishes in moist air. Dissolves in nitric acid. Volatilizes at high temperature. Lead salts are all poisonous. Hard water forms an insoluble coating on lead pipes, preventing oxidation

Preparations

A—$Pb(C_2H_3O_2)_2$ Sugar of Lead

B—PbO Litharge

Tests

A—HCl produces a white precipitate of lead chlorid: $PbCl_2$

Mercury

Symbol ..... Hg

Atomic weight 200

Occurrence

It is found free and in combination as a sulphid HgS (Cinnabar)

Physical and Chemical Properties

Silver white liquid metal forming mercuric and mercurous compounds

Compounds

A—Calomel (HgCl), white, odorless, tasteless, impalpable powder insoluble in water; with $NH_4(OH)$ forms a black solid

B—Corrosive sublimate ($HgCl_2$), a heavy, colorless, odorless crystalline solid, metallic taste, soluble in water; with $NH_4(OH)$ produces a white precipitate

C—Mercurous Iodid

HgI (hydrargyri iodidum flavum)

Properties

Yellow, amorphous powder, odorless and tasteless, almost insoluble in water

D—Hg_2O: mercurous oxid (black oxid)

E—HgO: mercuric oxid (yellow oxid)

F—HgI_2: red mercuric iodid

Silver

Symbol ..... Ag

Atomic weight 108

Occurs

Sometimes free, usually as argentiferous galena

Preparation

By many processes

a—By fusion with lead ore, also with copper ores and subsequent separation

b—By amalgamation

c—By lixiviation

d—By electrolysis

Properties

White, lustrous, very malleable and ductile; excellent conductor of heat and best conductor of electricity. Resists the action of oxygen. Soluble in nitric and sulphuric acids; blackened by sulphur. The ion of silver is univalent. Silver is unaltered by air or moisture. Silver takes a very high polish. Forms alloys with heavy metals

Compounds

A—$Ag(No_3)$ Silver nitrate (Lunar caustic)

B—New compounds: Argyrol and protargol

Bismuth

Symbol ..... Bi

Atomic weight 208

Occurs

By roasting the sulphid. Found in granite or clay slate

Properties

A reddish white, brittle, crystalline metal unchanged by air or water. Conductor of electricity, burns with blue flame soluble in HNO_3. Bismuth looks like antimony but is distinguished from it by its red tint

ORGANIC CHEMISTRY

GENERAL PROPERTIES

Definition

Chemistry of the combustible carbon compounds

Properties of organic matter

Completely consumed under continued heat forming H_2O and CO_2. The essential compound of plant and animal structures and their molecular composition may be very complex but includes only a few elements. Four elements that enter into the formation of most Organic Bodies

A—Carbon

B—Hydrogen

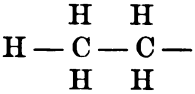
C—Oxygen

D—Nitrogen

Carbon is a black solid, cannot be fused or volatilized

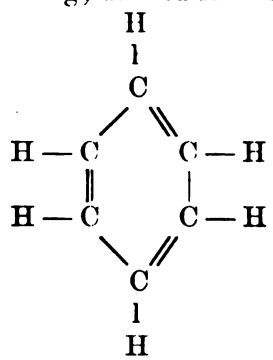
Hydrogen, oxygen and nitrogen, colorless gases; hydrogen combustible, oxygen a supporter of combustion, nitrogen indifferent. Hydrogen univalent, oxygen bivalent, nitrogen trivalent, carbon, quadrivalent. Hence the great variety of compounds. Properties of organic compounds are intermediate to elements; no organic compound is as solid as carbon or as gaseous as H or N. Some are solid; others gases or liquids, solid when carbon predominates

A—Open chain (aliphatic) compounds or fatty compounds; derived from methane or ethane united in series



$= C_2H_6$ Ethane

B—Closed (aromatic) compound: Carbons united in form of ring; derived from benzene



$= C_6H_6$ Benzene

Definitions

Substitution

Chemical changes which are produced by replacement of H by other atoms

$$K + H_2O = KOH + H$$

Derivatives

Bodies derived from others by decomposition or substitution

Isomerism

Bodies same composition but different properties

a—Metamerism

Molecule contains equal elements

$C_{12}H_{22}O_{11}$

Cane and milk sugar

b—Polymerism

Substances, multiple composition

C_2H_2 acetylene

C_6H_6 benzene

c—Stereo Isomerism

Same compounds differ physically

Destructive distillation

Decomposition by heat without oxygen

Action of Oxygen

A—Combustion

Rapid oxidation with evolution of heat and light

B—Decay

Slow oxidation without evolution of heat and light

Putrefaction

Decomposition of proteids by bacteria. Conditions necessary: nitrogenous substance, bacteria, warmth and moisture

Fermentation

Decomposition of carbohydrate by ferments

$C_{12}H_{22}O_{11} + H_2O = 2C_6H_{12}O_6$

Maltose Glucose

$C_6H_{12}O_6 = 2C_2H_5(OH) + 2CO_2$

Glucose Alcohol

$C_2H_5(OH) + O_2 = C_2H_4O_2 + H_2O$

Alcohol Acetic acid

Various forms

a—Alcoholic (vinous) producing alcohol and carbon dioxid. Enzyme Torula cerevisiae (Saccharomyces)

$C_6H_{12}O_6 = 2C_2H_5(OH) + 2CO_2$

b—Acetous, producing acetic acid. Enzyme Mycoderma aceti

$C_2H_5(OH) + O_2 = C_2H_4O_2 = H_2O$

c—Lactic, producing lactic acid. Enzyme Penicillium glaucum (Bacterium lacticus)

d—Butyric, producing butyric acid. Enzyme Bacterium butyricus

e—Viscous, producing gummy or ropy substances. Enzyme unknown

Isotonic

Solution having equal molecular concentration of the solids present

Example

A 0.9% solution of sodium chlorid is isotonic with the human blood

Hypo-isotonic

Solution of less concentration than an isotonic solution (hypotonic)

Hyperisotonic (Hypertonic)

Solution of greater concentration than isotonic solution

Classification of organic compounds

1—Hydrocarbons are compounds of hydrogen and carbon only

CH_4 Methane

C_2H_6 Ethane

C_6H_6 Benzene

2—Alcohol is the hydroxid of a hydrocarbon radical. It may be considered a hydrocarbon in which one or more of the hydrogens are replaced by OH

Example

a—Methyl alcohol..$CH_3(OH)$ Wood alcohol

b—Ethyl alcohol...$C_2H_5(OH)$ Grain alcohol

c—Benzyl alcohol..$C_6H_5(OH)$ Phenol

3—Ethers are oxids of hydrocarbon radicals, or they may be considered after the type of water in which both atoms of hydrogen have been replaced by an hydrocarbon radical

Example

H.....O.....H Water

C_2H_5..O.....CaH_5 or $(C_2H_5)_2O$ ethyl ether

A—Mixed ethers are ethers containing two different radicals, $CH_3OC_2H_5$ (Methyl Ethyl ether)

B—Compound ethers, from alcohol by replacing H of hydroxyl by acid radical. $C_2H_5OC_2H_3O$ (acetic ether)

4—Carbohydrates

A carbohydrate is an organic compound composed of carbon, hydrogen and oxygen, the hydrogen and oxygen being present in the same relative atomic proportions as in water; the carbon is six or a multiple of six. The carbohydrates are divided into the following groups

a—Monosaccharids

Cannot be further simplified

Example—Glucose ($C_6H_{12}O_6$)

b—Disaccharids

Can be divided into two other sugars

Example—Cane sugar ($C_{12}H_{22}O_{11}$)

c—Polysaccharids

Can be divided into many sugars

Example—Starch ($C_6H_{10}O_5$)

5—Proteins (Albumins)

Proteins (proteids) are very complex, unstable, mostly noncrystalline compounds comprising all albuminous substances, and are composed of C.H.N.O. and usually S.

Classification

1—Simple

Containing C.H.N.O. and S, i.e.
Serum Albumin

2—Compound

Containing a non-albuminous molecule such as hemoglobin

Physical properties

Non-crystalline solids insoluble in H_2O, soluble in H_2O containing a mineral salt. Non-diffusible except peptones and albumoses

3—Globulins

Insoluble in water but soluble in 1% solution of NaCl; contain less sulphur

4—Albuminoids

Definition

Substances related to albumins containing less carbon and more oxygen

Examples

Protamins—found in spermatozoa of some fish

Histons—found in red blood corpuscles and thymus of calf

Globulins—found in muscles, fibrin and clotted blood

Scleroproteids—found in bone, cartilage, connective tissues, skin, hair

Keratins—found in skin, hair, nails

Elastins—found in yellow elastic connective tissue

Collagens—found in white fibrous tissue, gelatin

Phosphoproteins—found in milk and eggs

Chondrin—found in cartilage

Neurokeratin—found in sheath of medullated nerves

Ossein—found in bone

Nucleoprotein—found in the cells of the body generally

Glucoproteins—found in mucin and connective tissues

Chromoproteins—found in oxyhemoglobin

Derived Proteins—found in the products of digestion of the proteins

Tests for Albumin

a—Xanthoproteic Reaction

A few drops of concentrated nitric acid are added to the solid albumin or its solution and boiled, a yellow color results. On the addition of an excess of ammonium hydroxide a deep orange yellow is produced

b—Millon's reaction

Solid albumin or its solution when heated with Millon's reagent (solution of mercuric nitrate containing nitric acid) yields a brick red solid

c—Biuret Test

When a solution of albumin is boiled with Fehling's solution, the albumin is coagulated and turns violet

5—Albumoses (Proteose) produced by

Action of enzymes on proteid; soluble in water and in saline solutions

Examples

Globuloses

Vitelloses

Caseoses

6—Amins

Amins are substitution compounds of ammonia in which one or more atoms of hydrogen are replaced by a basic organic radical

Examples

Ethylamin $NH_2C_2H_5$

Phenylamin $C_6H_5NH_2$ (Anilin)

7—Amids

Amids are substitution compounds of ammonia in which hydrogen is replaced by an acid radical. They result when NH_2 replaces H in acids

Examples

Urea—$CO(NH_2)_2$

8—Aldehyds (Dehydrogenated Alcohols)

Definition

(Dehydrogenated alcohols) are alcohols from which two atoms of hydrogen have been extracted by oxidation

Examples

Formaldehyd, HCOH, obtained by the oxidation of methyl alcohol, $CH_3OH + O = H_2O + HCOH$

9—Acids

Organic acids are compounds in which hydrocarbon radicals are united to carboxyl (COOH); may be considered as hydrocarbon; in which one or more of the hydrogen has been replaced by COOH

Examples—$C_6H_5(COOH)$ Benzoic acid

10—Esters

Called also compound ethers, are formed from the acids by substituting a hydrocarbon radical for the hydrogen in the carboxyl radical (COOH)

Examples—$C_2H_5OH + CH_3CO_2H =$
$C_2H_5COOCH_3 + H_2O$

11—Ketones

Are derived from the acids by substituting a hydrocarbon radical for hydroxyl or they are compounds of two hydrocarbon radicals with carbonyl, CO

CH_2CO, CH_3 Acetone

HYDROCARBONS

Definition

Organic compound containing carbon and hydrogen only

'ATURATED HYYDROCARBONS

'ARAFFIN, FATTY, OR ALIPHATIC SERIES

Homologues

Members

Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}
Pentane	C_5H_{12}
Hexane	C_6H_{14}
Heptane	C_7H_{16}

General Chemical Features

The above series differ by CH_2 in each member and have a general composition $CnH_2n + 2$. They are chemically alike. For this reason the series is called Homologues. When the carbon remains the same, but the hydrogen differs

by H_2, the series is said to be Isologues, e.g., C_2H_2, C_2H_4, C_2H_6

Occurrence

Products of vegetable life

Source

Destructive distillation or fractional distillation

Properties

Containing less than 5 carbons are gases: 5–12 carbons liquids; over 12 carbons, solids; volatilized without decomposition; colorless; peculiar and characteristic odor; insoluble in H_2O; soluble in alcohol

Derivatives

Coal

Carbon, associated with H and O, formed in vegetable matter by decomposition; also vaseline obtained from petroleum by distillation. Vaseline is a fat-like mass; yellowish color, used as a dressing for wounds

Natural Gas

Gases given off during formation of coal

Coal oil (Petroleum)

Product of decomposition of fats and oils of fish

Illuminating gas

Mixture of gases produced by destructive distillation of wood or coal

Methane

Methane (Marsh Gas) CH_4

Occurs

Found in coal gas produced by decaying vegetable matter. In coal mines called fire-damp. It forms the principal part of natural gas, also of illuminating gas made from the distillation of soft coal

Preparation

$CH_3CO_2Na + NaOH = CH_4 + Na_2CO_3$

Properties

A colorless, odorless gas

Causes suffocation; burns with a non-luminous flame

It is very stable and unaffected by chemical agents

UNSATURATED HYDROCARBONS

OLEFIN SERIES

General

All hydrocarbons corresponding with the formula C_nH_{2n}, combine with the halogens without an exchange of hydrogen. They are called unsaturated hydrocarbons, because they

unite directly with an element or a compound. The nomenclature differs from the paraffins by changing the ane to ene

Source

Are found in petroleum, in products of the destructive distillation of coal and wood

Ethane or Ethylene

Symbol..... C_2H_4 (Olefiant gas)

Occurs

As a constituent of illuminating gas

Prepared

$C_2H_5Br + KOH = C_2H_4 + KBr + H_2O$. Also prepared by destructive distillation of coal

Properties

A colorless gas, faint ethereal color, slightly soluble in water, but more so in alcohol. Burns with a bright luminous flame

ACETYLENE SERIES

General

The acetylene hydrocarbons are unsaturated hydrocarbons

Acetylene

Symbol..... C_2H_2

The only hydrocarbon which can be made by direct union of its component elements

Occurs

As a constituent of coal gas

Prepared

$C_2Ca + 2H_2O = C_2H_2 + CaH_2O_2$

Properties

Acetylene is a colorless, odorless gas. When impure it has an odor like garlic. Burns with a brighter flame than olefiant, but gives off smoke. By using an acetylene jet it produces a most brilliant light. The hydrogen of acetylene is easily displaced by metals. When heated by a red hot surface without air, the three molecules change to benzene C_6H_6

HALOGEN DERIVATIVES OF METHANE

Methyl Chlorid

Symbol..... CH_3Cl

Prepared

$CH_4 + Cl_2 = CH_3Cl + HCl$

Properties

Methyl chlorid is a colorless gas, peculiar odor and sweet-

ish taste. By its evaporation it produces intense cold. Used locally in neuralgia

Chloroform

Symbol.....$CHCl_3$ (Trichlormethane)

Prepared

Distilling chloral with sodium hydroxid

$CCl_3CHO + NaOH = CHCl_3 + HCOONa$ (Formate of soda)

Properties

A clear colorless, heavy liquid, volatile and having a burning sweet taste and ethereal odor. Neutral reaction. Chloroformum Purificatum for inhalation contains 1% alcohol. Commercial chloroform contains hydrocarbons, HCl, free chlorin and aldehyd

Test for Impurities

Specific gravity, not under 1.490. Shake with one-half volume of water, separate the water and test with litmus. If latter turns red it indicates HCl. Shake a mixture of equal volumes with sulphuric acid (pure). If on standing a brown color develops it shows inorganic matter present. Aldehyds may be shown by shaking a mixture with potassium hydroxid; if present it turns brown

a—Alcohol

A specific gravity lower than 1.476 at 25 degrees C indicates too much alcohol. From 0.6 to 1 per cent. of alcohol is allowable and renders the chloroform more stable

b—Chlorin

If one volume of chloroform and two volumes of water are thoroughly shaken and then allowed to separate, the watery solution upon the addition of potassium iodid yields a yellow color, due to liberation of iodin by the chlorin. If the watery solution is treated with silver nitrate a milkiness or white precipitate of silver chlorid is produced

c—Hydrochloric acid

A watery solution obtained in the manner described under chlorin turns litmus paper red; with silver nitrate the solution yields a white precipitate (AgCl)

d—Aldehyd

Chloroform when shaken with potassium hydroxid burns brown if aldehyd is present

e—Water

Anhydrous copper sulphate added to the chloroform is dissolved if water is present, producing a blue color

Test for Chloroform

A—Chloroform reduces Fehling's solution when boiled, to red cuprous oxid

B—Dissolve B-naphthol (0.01 gm.) in a strong solution of potassium hydroxid, heat and add chloroform. A blue color, changing to green and brown results

Iodoform

Formula.....CHI_3 (Tri-iodomethane))

$C_2H_5OH + 4I_2 + 6KOH = CHI_3 + HKCO_2 + 5KI + 5H_2O$

Properties

A solid yellow substance, crystallizes in brilliant yellow hexagonal scales; peculiar odor; a sweet, unpleasant iodin taste. The odor is usually sufficient for detection.

HALOGEN DERIVATIVES OF ETHANE

Ethyl Chlorid

Formula.....C_2H_5Cl (Monochlorethane)

Prepared

By heating oil of vitriol with sodium chlorid

Properties

A gas at ordinary temperature; under pressure it is a colorless, volatile liquid; penetrating aromatic odor; inflammable, burning with a green tinged flame. Used as a local anesthetic

Ethyl Bromid

Formula.....C_2H_5Br (Hydrobromic ether) (brom-ethane)

Prepared

Distilling bromin and phosphorus

Properties

Volatile, heavy, colorless liquid, smells like chloroform, has a burning taste, used as an anesthetic but not safe

OXYGEN DERIVATIVES OF HYDROCARBONS

Alcohols

Definition

Alcohols are hydrocarbons in which one or more hydrogen atoms have been replaced by hydroxyl. They are called mono, di, tri, or tetratomic, according to the number of hydroxyls they contain

Classification

A—Monatomic alcohol in which one H is replaced by one hydroxyl

$CH_3(OH)$ Methyl alcohol

B—Diatomic alcohol in which 2 are replaced by 2 hydroxyls

$C_6H_4(OH)_2$ Resorcin

C—Triatomic alcohol in which 3H are replaced by 3 hydroxyls

$C_3H_5(OH)_3$ (Glycerin)

D—Primary alcohol, hydroxyl group linked to carbon which is united to one other carbon

CH_3-CH_2-OH Ethyl alcohol contain $CH_2(OH)$ group

E—Secondary alcohol, hydroxyl group linked to a carbon which is linked to two other carbons

CH_3
\
CH-OH-(Iso-propyl alcohol) contain CHOH group
/
CH_3

F—Tertiary alcohol, hydroxyl group linked to 3 other carbons

CH_3
\
CH_3—C-OH Butyl alcohol contain COH group
/
CH_3

Occurrence in nature

In association with acids; in compound ethers

Formation

Fermentation or destructive distillation

Properties

Colorless, neutral liquids, lighter than water. Volatile without decomposition, oxygen may be replaced by S to form mercaptans

Methyl Alcohol

Formula.....$CH_3(OH)$ (Wood spirit or wood naphtha)

Found

In nature, combined with oil of wintergreen

Preparation

Dry wood, heated in retorts and the distilled vapors condensed. It is separated from the creosote and acetic acid by fractional distillation

Properties

Colorless liquid, aromatic odor, burning taste, inflammable, burning with an almost invisible flame; used in spirit

lamps, to make varnish; solvent for fats and oils; concentrated it is a poison

Ethyl Alcohol

Formula.....C_2H_5OH (Spirits of wine, Ethyl hydroxid grain alcohol)

Preparation

Fermentation of sugar

$C_6H_{12}O_6$ sugar $= 2C_2H_6O$ alcohol $+ 2CO_2$

Properties

A colorless, volatile, mobile liquid. It has a burning taste and characteristic odor. Burns with a smokeless flame. Evaporates on exposure to air and absorbs water readily. Takes fire easily. By oxidation alcohol changes first into aldehyd: CH_2CHO, then into acetic acid: $CH_3(COOH)$

Alcoholic Beverages

Stout	4– 6%	alcohol
Beer	2– 4%	"
Ale	5– 6%	"
Porter	1– 8%	"
Wines		
Claret	7%	"
Rhine	11%	"
Sherry	16%	"
Madeira	19%	"
Port	20%	"
Brandy	50%	"
Whiskey	50%	"
Gin	40%	"
Rum	45%	"
Champagne	11.75%	"

Contaminations and Tests

A—Fusel oil, composed largely of amyl alcohol with other substances. No foreign odor should be perceptible when the last traces of alcohol in a mixture of 10 cc. alcohol with 5 cc. water and 1 cc. glycerin have evaporated spontaneously from a piece of clean odorless blotting paper

B—Amyl alcohol; no red or brown color should be produced on the addition of a few drops of pure, strong sulphuric acid

C—Aldehyd; when 10 cc. of alcohol in a test-tube is mixed with 5 cc. of potassium hydroxid test solution (U.S.P.) the liquid should not at once assume a brown color

ETHERS

Definition

May be considered as compounds derived from alcohols by substituting an alcohol radical for the H in the OH group, $C_2H_5OC_2H_5$, or may be considered after the plan of water in which each hydrogen is replaced by hydrocarbon radical

$C_2H_5 — O — C_2H_5$ (Ethyl ether)

Ethyl Ether

Formula.....$(C_2H_5)_2O$ (Anesthetic ether, sulphuric ether, ethyl oxid)

Prepared

Distilling alcohol with sulphuric acid

$C_2H_5OH + H_2SO_4 = H_2O + C_2H_5HSO$

$C_2H_5HSO_4 + C_2H_5OH = H_2SO_4 + (C_2H_5)_2O$

Properties

Volatile and inflammable. Soluble in alcohol. Solvent of fats, alkaloids and collodion. Detected by its odor

Test

A yellow spot made on filter paper with potassium bichromate and H_2SO_4 turns green by the action of ether vapors

ALDEHYDS

Definition

Alcohol dehydrogenatum: aldehyds are oxidized alcohols. Intermediate between alcohols and acids. Aldehyds the result of the removal of two atoms of H from the alcohols, *e.g.*,

CH_4O (Methyl alcohol) $+ O = CH_2O$ (formaldehyd) $+ H_2O$

Formaldehyd

Formula.....CH_2O (formic or methyl aldehyd)

Prepared

$Ca(HCO_2)_2 = CaCO_3 + HCOH$

Properties

Calcium formate: A suffocating, colorless gas. Soluble in water. Formalin is a 40 per cent. solution, powerful antiseptic and deodorizer

Test

To a solution of resorcin, add potassium hydroxid. When heated with an equal volume of formaldehyd it gives a red color

KETONES

Definition

These may be regarded as being formed from the acids by removal of the radical OH from the COOH group and substitut-

ing one of the hydrocarbon radicals of the alcohols for it; *e.g.*, CH_3CO, CH_3 (acetone) or they may be considered as aldehyds of a secondary alcohol. Ketones always end with the suffix one. They are for the most part volatile liquids insoluble in water. Hydrogen reduces them to secondary alcohols

Acetone

Formula.....CH_3COCH_3 (Dimethyl ketone)

Occurs

In the blood and urine in small quantities. In diabetics it is found in the urine in large quantities

Prepared

Distillation of sugar, wood, citric and tartaric acids

$$Ca(CH_3CO_2)_2 = (CH_3)_2CO + CaCO_3$$

Properties

Colorless mobile liquid, burns with a luminous flame. It dissolves resins and fats

FATTY ACIDS

Definition

Acids are derived from fats, they are known also as the acetic series of the organic acids. The lower members are colorless liquids; the intermediates are thick, oily liquids; the higher ones crystallize as solids. Each acid contains one carboxyl group. The H of the latter can be replaced by a radical or by a positive element. The lower members of the fatty acids are very acid and freely soluble in water. The higher members containing more C and H; are feebly acid; not soluble in water, but soluble in alcohol and ether

Acetic Acid

Formula.....$CH_3(COOH)$ (methylformic acid)

Definition

Acetic acid is the product of the oxidation of alcohol. Vinegar is a dilute solution of acetic acid

Prepared

By the destructive distillation of sawdust or wood. Vinegar is the product of acid fermentation of alcoholic liquids

Properties

A strongly acid liquid, pungent odor, solidifies in cold to crystalline plates. Burns with a flame like alcohol. One of the most stable organic acids. Forms acetates. Soluble in water, alcohol and ether

Tests

With ferric chlorid it gives a deep red color which, when boiled, changes to a red brown precipitate of ferric subacetate. Other fatty acids

Oxidation products of aldehyds
Stearic acid $C_{18}H_{35}O_2$
Palmitic acid $C_{16}H_{32}O_2$
Oleic acid $C_{18}H_{34}O_2$

FATS

Definition

Fats are compounds of the glyceryl radical and a fat acid radical

1—Emulsification

Suspension of fat in liquid by means of acacia

2—Saponification

Union of fatty acid with alkali to form a soap

Names and formulae of these fats

A—Stearin .....$C_3H_5O_3(C_{18}H_{35}O_2)_3$
B—Palmitin .....$C_3H_5(C_{16}H_{31}O_2)_3$
C—Olein .....$C_3H_5(C_{18}H_{33}O)_3O_3$

AROMATIC SERIES

General

These are derived from benzol or benzene, called also the benzene series; obtained mostly from aromatic oils, resins and from coal tar, differ from the fatty compounds in that they have a larger number of carbon atoms

Benzene

Formula.....C_6H_6) (Benzol)

Obtained

Distillation of coal tar

$$C_7H_6O_2 = C_6H_6 + CO_2$$

Properties

A light, colorless, ethereal liquid, aromatic odor, very inflammable, insoluble in water, soluble in alcohol and ether, burns with a red, smoky flame, dissolves iodin, phosphorus, sulphur, fats, and many organic substances

Uses

Used in production of aromatic compounds

Example

Anilin
Phenol
Salicylic acid
Resorcin

Phenol

Definition

These are benzene hydroxids. They are aromatic hydrocarbons; in phenols one or more H atoms of the benzene

have been replaced by OH (hydroxyl). They are therefore hydroxyl derivatives of benzene

Formula.....C_6H_5OH (carbolic acid) (phenol)

An hydroxybenzene. Obtained by fractional distillation from coal tar

Properties

Colorless, crystalline substance, characteristic odor, and burning taste. Exposed to air turns pink. Deliquesces. It coagulates albumen. Powerful antiseptic

Tests

A—Odor

B—Coagulates albumen

C—Boiled with mercuric nitrate (Millon's reagent) carbolic solutions turn red

D—Strong bromin water, gives a precipitate of white crystals of tribromphenol

Anilin

Definition

Benzene derivative: phenylamin

Formula

$C_6H_5NH_2$

Source

Reduction of nitrobenzene

$$C_6H_5(NO_2) + 3Fe + 6HCl = C_6H_5NH_2 + 3FeCl_2 + 2H_2O$$

Derivatives

A—Anilin dyes, substituting hydrogen of anilin by various radicals

B—Medicinal substances, acetanilid and phenacetin

Creosote

Definition

Mixture of phenols such as guaiacol, creosol, and cresol

Source

Distillation of coal tar

Physical properties

Yellow oily liquid, smoky odor, burning taste

Uses

A—Locally in toothache

B—Antiseptic

C—Caustic

Saccharin

Definition

Amin compound obtained from coal tar

Physical properties

White, crystalline powder, odorless, intensely sweet (280 times sweeter than sugar)

Uses

Diabetes and gout

AROMATIC ACIDS

Definition

Formed by replacing the H atom in benzol and its homologues by carboxyl, COOH

Formula

C_6H_5COOH (Benzoic acid)

Found

In gum benzoin and balsam Peru

Obtained

$C_6H_5CCl_3 + 2H_2O = C_6H_5CO_2H + 3HCl$

Properties

Crystallizes in needles or feathery scales; an aromatic odor; forms benzoates of sodium, lithium, calcium, etc.

Test

A neutral solution with neutral ferric chlorid gives a red precipitate of ferric benzoate

SALICYLIC ACID

Formula.....$H(C_7H_5O_3)$

Source

Oil of wintergreen

Properties

White needle-shaped crystals, odorless, sweet taste

Uses

Rheumatism

Antiseptic, disinfectant

Tests

With $FeCl_3$ produces violet color

GASTRIC ANALYSIS

Test breakfast

Ewald's

One large slice of bread and a glass of water; removed in one hour

Chemical examination

1—Free hydrochloric acid

Qualitative

a—Congo red—turns blue

b—Place in porcelain dish, evaporate to dryness, touch with tropeolin, turns blue

c—Filter stomach contents; add a few drops of Guenzburg's reagent;

Phloroglucin ..... 2 grams
Vanilin ..... 1 gram
Alcohol .....30 cc.

turns to rose red on evaporation in a porcelain dish

Quantitative

To 10 cc. of gastric contents add three to four drops of a solution of Toepfer's reagent (dimethylamido-azobenzol). Titrate with a decinormal (N/10)NaOH solution until the disappearance of the carmine red color which is replaced by a yellow color. This point represents the neutralization of the free HCl in the contents used. To estimate the quantity of free HCl multiply the number of cc. of (N/10)NaOH used in this titration by 10. This gives the amount of free HCl in 100 cc. gastric contents in terms of (N/10)Na(OH). This is the simplest method of recording the acidity. The result may be expressed in per cent. of HCl if the above quantity is multiplied by 0.00365. (This is the quantity of HCl which is neutralized by 1 cc. (N/10)NaOH)

2—Total acidity

To the same contents in which the free HCl has already been neutralized, add two or three drops of a one per cent. solution of Phenol-phthalein. Continue the titration with the (N/10)NaOH solution until a permanent red color is obtained. This represents the neutralization of all the acid constituents of the contents (the free mineral and organic acids and the combined acid). To estimate the total acidity multiply the number of cc. of (N/10)NaOH used from the beginning of titration up to this point by 10. This gives the total acidty of 100 cc. gastric contents in terms of (N/10)NaOH. The result may be expressed in per cent. HCl by multiplying the above quantity by 0.00365. The normal quantitative values of total acidity vary between 0.15% and 0.30% or 40–80 cc. (N/10)NaOH per 100 cc. gastric contents

3—Lactic acid

Uffelmann's

Consists of a solution of Fe_2Cl_6 and phenol diluted to an amethyst color, which is changed to yellow by lactic acid. In order to avoid error by the action of other substances which have a like action upon the reagent 10 cc. of the filtered gastric contents are agitated with ether, and the ethereal extract separated and agitated with the reagent; or it may be evaporated, the residue dissolved in water, and the solution added to the reagent

4—Blood

A—Shake with equal volume of ether to remove the fat and discard the ether

B—Treat remainder, with 1/3 its volume, of acetic acid and extract with ether

C—Overlay the liquid with a solution of equal parts of ozonized turpentine and tincture of guaiac

D—A blue ring at zone of contact indicates blood

5—Toepfer Method

A—Total acidity

To 10 cc. of gastric juice in a beaker add 2 to 3 drops of phenolphthalein and titrate with a decinormal. Na(OH) solution until the solution turns pink. Suppose it required 10 cc. of N/10Na(OH) then to find quantity required in 100 cc. multiply by 10. This will give 100 cc. of N/10 Na(OH) required to neutralize total acidity of 100 cc. of gastric juice, then multiply the 100 by .00365 and result is .36% of total acidity

B—Free HCl

To 10 cc. of gastric juice add 2 to 3 drops of dimethyl-amido-azo benzol (red), and titrate until solution turns yellow; this indicates that all the free HCl has been neutralized. Suppose it required 1 cc. of N/10Na(OH) then in 100 cc. of gastric juice it would require 10 cc. multiplied by .00365 would give .03% of free HCl

C—Combined HCl

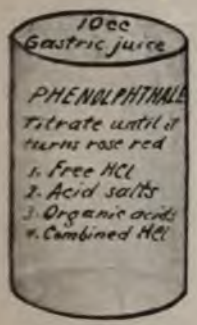
To 10 cc. of gastric juice add 2 to 3 drops of sodium alizarin sulphonate and titrate until it turns purple, this neutralizes all acids *except combined HCl.* Suppose 2 cc. were required of N/10Na(OH)—subtract this from total acidity, which required 10 cc. and result is 7 cc. of combined HCl, multiplied by 10 to find

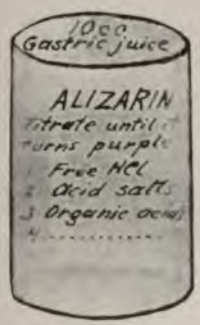
PLATE XI

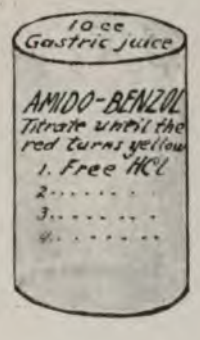
PHENOLPHTHALEN
End reaction

ALIZARIN
End reaction

Amido Benzol
End reaction







quantity in 100 cc. and again multiplied by .00365 will give 0.25%.

D—Acid salts

To obtain acid salts, add the free HCl (.03) and the combined HCl (0.25) and subtract from the total acidity (.36); result is 0.08%

Note

A—One cc. of N/10Na(OH) neutralizes .00365 gm. of HCl, remember the figure by the number of days in the year and the last figure indicates number of decimal places

B—A normal solution is the molecular weight of the substance in grams dissolved in a liter of water; for Na(OH) it would be (sodium 23), (Oxygen 16), (Hydrogen 1); (forty grams in a liter of water, a decinormal solution (N/10) is one-tenth strength) . . . . . .

URINALYSIS

Composition of Urine

	(Parts in 1000)
Water	950.00
Urea	28.00
Uric acid	0.60
Hippuric acid	0.35
Creatinin	0.65
Extractives	8.00
Sodium chlorid	8.00
Phosphoric acid	2.00
Sulphuric acid	1.25
Lime (CaO)	0.25
Magnesia (MgO)	0.30
Potash (K_2O) and soda (Na_2O)	0.60
Total.....	1000.00

Examination

1—Physical Description

A—Amount 1500 cc.

B—Color, amber (due to urochrome, urobilin, uroerythrin

C—Reaction, acid, turns blue litmus red due to acid sodium phosphate

D—Odor, characteristic

E—Specific gravity, 1.015–1.025 obtained with urinometer
F—Solids—multiply last two figures of specific gravity by 2.33 and this will give solids for liter of urine

Chemical

1—Chlorids

Qualitative

Acidify with HNO_3, add $AgNO_3$; produces a white precipitate of AgCl insoluble in HNO_3 but soluble in $NH_4(OH)$

Quantitative

Uranium Method

Take 50 cc. of urine, add 5 cc. of sodium acetate solution, of which 1 liter contains 100 gm. sodium acetate, 100 cc. of 30% acetic acid, and a few drops of tincture cochineal. Heat to boiling and then from a buret run in the standard uranium acetate solution (1 cc. equals 0.005 gm. P_2O_5) until a faint permanent green color is produced. Multiply the number of centimeters of uranium acetate required and then by 2 to obtain the percentage of P_2O_5

2—Phosphates

Make acid by HNO_3, add ammonium molybdate; yellow precipitate of ammonium phosphomolybdate results

Decrease

a—Acute infectious diseases
b—Decreased metabolism

Increase

a—Diabetic mellitus
b—Phosphaturia
c—Typhoid

3—Urea

A—Qualitative

Add nitric acid to urine on glass slide; crystals of urea nitrate form

B—Quantitative

Fill a ureometer with sodium hypobromite solution (100 grams of sodium hydroxid in 250 cc. of H_2O with 25 cc. of bromine); add 1 cc. of urine, read off percentage of urea in terms of nitrogen on a graduated scale beside the tube

4—Indican (Potassium indoxyl sulphate)

The urine is mixed with one-fifth its volume of a 20 per cent. solution of lead acetate and filtered. The filtrate is

mixed with an equal volume of fuming hydrochloric acid containing 3/1,000 of ferric chlorid; a few drops of chloroform is added and the mixture strongly shaken one to two minutes. With normal urine the chloroform remains colorless, or almost so; but if an excess of indoxyl compounds be present the chloroform is colored blue and the depth of the color is a rough indication of the degree of the excess

5—Uric acid

Amount.....7.7 gr. per diem excreted in urine

Relation of uric acid to nucleoproteid

Source of Uric acid

Proteid Nuclein

Proteid Nucleinic acid

Phosphoric acid, Nuclein or xanthin alloxuric or puric bases. The purin $C_5N_4H_4$ under oxidative processes yields—

Hypoxanthin (oxypurin) $C_5N_4H_4O$

Xanthin (dioxypurin) $C_5N_4H_4O_2$

Uric acid (trioxypurin) $C_5N_4H_4O_3$

Microscopic

Shows brick red deposit, with great variety of crystals: rhombic, lozenge, double wedges, crosses, rosettes; also occurs as amorphous urates

Test

Qualitative

Murexid test

Evaporate urine to dryness in porcelain dish, add few drops of HNO_3; again evaporate, add $NH_4(OH)$, a purple red color develops

Quantitative

Heintz method

Add to 200 cc. of filtered albumin free urine, 10 cc. of hydrochloric acid, and allow to stand twenty-four hours. Collect the uric acid crystals on equipoised filters, wash with 30 cc. of water, dry and weigh. Divide the weight obtained by 2 to obtain the percentage and compare it with the normal percentage

6—Formaldehyd H(COH)

Urine with H_2SO_4 and $FeCl_3$ produces a bluish violet color

7—Glucose

Qualitative

a—Fehling's solution, add urine; yellow precipitate of

cuprous hydroxid or red precipitate of cuprous oxid is formed

Reaction

1—When the two parts of Fehling's solution are mixed the following reaction occurs

$$CuSO_4 + 2KOH = Cu(OH)_2 + K_2SO_4$$

If glucose is present in the urine, oxygen is taken out and cuprous oxid is formed

$$2Cu(OH)_2 = 2H_2O + O + Cu_2O$$

b—To make Fehling's

1—Dissolve cupric sulphate 51.98 gm. in water to 500 cc.

2—Dissolve Rochelle Salts 259.9 gm. in sodium hydroxid solution specific gravity 1.12 to 1,000 cc.

Take equal parts of solutions No. 1 and 2; heat and add urine drop by drop until red precipitate forms

c—Nylander's test

2 gm. bismuth subnitrate ($BiONO_3$); 5 gm. Rochelle Salts; 10 gm. (Na OH) in 90 cc. water; filter. Heat ½ of this solution with about 5 cc. urine; brown on black precipitate forms in a few minutes if sugar is present

d—Trommer's Test

To test tube ½ full of urine, add ¼ volume of Na(OH), and $CuSO_4$, boil; yellow or red precipitate shows sugar

e—Test for sugar

First remove any albumin that may be present then render the liquid strongly alkaline by addition of sodium carbonate. Divide about 6 cc. of the alkaline liquid in two test tubes. To one test tube add a very minute quantity of powdered litharge. Boil the contents of both tubes. The presence of the glucose is indicated by a dark or black color of the bismuth powder, the litharge retaining its natural color

f—Fermentation test

g—Phenylhydrazin ($C_6H_8N_2$)

In test tube place ¼ inch of powdered phenylhydrazin hydrochlorid and twice the volume of sodium acetate, fill tube half full of urine, boil for ½ hour. On cooling, pres-

ence of glucose gives sulphur yellow needle-shaped crystals of phenyl-glucosazone; seen microscopically

Quantitative

Fehling's Method: Place 10 cc. of Fehling's solution into a beaker with 40 cc. of water and boil (0.050 gm. glucose required to reduce 10 cc. Fehling's). Run into the Fehling's from a buret the urine, previously diluted with water in the proportion of one part urine to nine parts water, boil constantly until the blue color disappears. This indicates complete reduction of the copper to cuprous oxid. Read off the number of centimeters of diluted urine required and calculate the percentage of glucose as follows

Suppose 10 cc. diluted urine required: one-tenth of 10 equals 1 cc. undilated urine required; equals 0.050 gm. glucose to obtain percentage, find the quantity in 100 cc. which is 5%

8—Albumen

Qualitative

a—Heat, a white precipitate forms which is either albumen or phosphates; add acetic acid, if it dissolves out, it is phosphates, if not dissolved, it is albumen

b—Heller's Test

Stratify urine over nitric acid in test tube; in presence of albumen a white zone appears

c—Potassium Ferrocyanid; acidify urine, add 10% solution of potassium ferrocyanid; a precipitate forms in presence of albumen

Quantitative

Esbach's albumenometer

1—Description

Glass tube, graduated and lettered, used for quantitative estimation of albumen

2—Reagent

Picric acid 10 parts
Citric acid 20 parts
Distilled water 1,000 parts

3—Technique

Fill tube to letter U with urine, to mark R, with reagent; cork, shake up, set aside for 24–48 hours

4—Result

The precipitate at bottom of tube indicates number of grams of albumen in 1,000 cc. of urine

9—Mucin

With acetic acid gives a white precipitate

10—Blood

Test

a—To suspected material add freshly prepared tincture of guaiac, then add an oxidizing agent like turpentine or hydrogen peroxid; a blue color will appear

b—Hemin crystal test (Teichmann)

Place suspected material with a few crystals of sodium chlorid on slide; as you heat, allow glacial acetic acid to flow under slide. If blood is present, on cooling hemin crystals under microscope are seen

b—Bordet, biologic test

Rabbit is sensitized by injecting human blood until serum is capable of precipitating human blood. This sensitized serum when mixed with human blood will cause coagulation

11—Diazo Reaction

For the Diazo reaction (Ehrlick) two solutions are required

1—A saturated solution of sulphanilic acid in a mixture of 50 cc. of hydrochloric acid and 950 cc. of water

2—A 0.5 per cent. solution of sodium nitrate. Add 1 cc. of number 2 to 40 cc. of number 1; shake thoroughly. Shake in a test tube equal parts of this mixture and the urine to be tested; then float 1 cc. of ammonia upon the surface; in an affirmative result, a red band is formed at the junction of the fluids. Diagnostic: typhoid. Prognostic: tuberculosis

12—Bile

A—Gmelin's test (for bile pigments)

Put nitric acid in a test tube and heat until the acid is yellow; cool; then float some of the urine on the surface of the acid. If bile pigments are present a green band is formed at the junction of the two liquids, which gradually rises and is succeeded from below by blue, reddish violet, and yellow

Pettenkofer's

10% solution of cane sugar and concentrated sulphuric acid develops a cherry red color in presence of biliary acids

B—Smith's test (for bile pigments)

Stratify bile with tincture of iodin; emerald green color is produced at zone of contact

13—Acetone

Distil the urine, render it alkaline with Na(OH), add a few drops of sodium nitro-prussid, a red color is produced which disappears and returns when treated with $H(C_2H_3O_2)$

14—Diacetic acid (Aceto-acetic)

$FeCl_3$ produces a red color which disappears on boiling

15—Alkaptons

Render alkaline with Na(OH); turns brown or black if homogentisic acid is present

16—Pus

Acidify the urine with acetic acid, then filter it and treat the filter with a few drops of freshly prepared tincture of guaiac; a deep blue color denotes the presence of pus

17—Order of frequency and chemical composition of urinary calculi

A—Uric acid 70 to 80 per cent.

B—Calcium oxalate: Small, round, and smooth, called "hemp-seed calculi"; or large, rough masses called "mulberry calculi"

C—Phosphates

a—Calcium phosphate

1—$CaH_4(PO_4)_2$ acid salt

2—$CaHPO_4$ neutral salt

3—$Ca_3(PO_4)_2$ basic

b—Magnesium ammonium phosphate (triple phosphate $MgNH_4PO_4$)

c—Fusible phosphates composed of (*1*) and (*2*) varieties with more or less organic matter

D—Rarer forms are

a—Cystin with calcium carbonate

b—Indigo and xanthin

Microscopic—look for

Nonorganized deposits

Amorphous

Crystalline

Organized deposits

Epithelium
Leukocytes
Erythrocytes
Casts
Bacteria

MILK EXAMINATION

Normal Milk

Physical Properties

Opaque, bluish white sweet liquid, characteristic odor, reaction alkaline, specific gravity 1.030

Composition

Water	86.95
Casein with albumin	4.4
Butter fat	3.65
Lactose	4.25
Salts	.75
	100.00

To Separate Fat

Take a test tube one-third full of milk, add equal parts of ether and potassium hydroxid; ether dissolves fat, floats on top; by evaporation fat is left as a residue.

Milk Sugar

Add HCl and warm; this gives a precipitate known as acid curd; filter the whey and test filtrate with Fehling's.

Phosphates

Add magnesia mixture: phosphates are precipitated.

Chlorids

Add silver nitrate: chlorids are precipitated.

To estimate fat

Feser's lactoscope: the figure on right of cylinder indicates amount of fat; the point on the left indicates amount of water added.

To estimate proteid

Employ Esbach's reagent

Cream

The quantity of cream may be measured with the creamometer. If the specific gravity be 1.033, less than 10 per cent. cream, indicates skimmed milk. If the specific gravity be under 1.020 less than 20 per cent. cream, denotes watered milk.

Preservatives

A—Formaldehyd

Add H_2SO_4 with a trace of $FeCl_3$: result purple color.

B—Borax or Boric acid

Take 1 drop of suspected milk, add two drops of strong HCl, two drops of saturated turmeric tincture. Place these in a porcelain dish, dry on a water bath, and after cooling add a drop of ammonia. A slate blue color which changes to green results if either borax or boracic acid be present.

C—Salicylic acid

Precipitate proteid and fat by means of acetic acid or nitrate of mercury. Add ether to filter; evaporate; may see crystals; dissolve in alcohol and add $FeCl_3$: a violet color produced.

TOXICOLOGY

Definition

That science which treats of character, antidotes, and detection of poisons.

Poison

Definition

A substance by acting chemically on the body causes death or deleterious results.

Classified

A—Corrosive poisons

B—Poisons proper

a—Mineral poisons

b—Vegetable poisons

c—Animal poisons

d—Synthetic poisons

C—Evidence of poisoning

a—Symptoms

b—Postmortem examination

c—Chemical analysis

D—Antidote

Agent which counteracts effects of poison.

1—Physical

Removes poison before absorption, such as a stomach tube.

2—Chemical

Combines with poison to form new insoluble or inert compound; example, sodium chlorid for silver nitrate poisoning $AgNO_3 + NaCl = AgCl + NaNO_3$.

3—Physiological

Counteracts effects of poison after absorption.
Example—atropin for morphin poisoning

E—Specific antidotes
a—Silver nitrate; sodium chlorid
b—Heavy metals
1—Potassium iodid
2—Albumin
3—Tannic acid
4—Sodium bicarbonate
c—Corrosive sublimate
1—Albumen and stomach tube
d—Tartar emetic
1—Tannic acid
e—Acids
1—Alkalis
A—Lime water
B—Chalk and soap
C—Magnesium oxid
f—Copper sulphate
1—Potassium ferrocyanid and lime water
g—Iodin
1—Starch
h—Phosphorus
1—Copper sulphate, forms copper phosphid
2—Turpentine, old French variety, forms P_2O_5
i—Hydrocyanic acid
Ferric hydroxid with magnesium oxid forms prussian-blue.
j—Arsenic
Liquors ferri hydroxid cum magnesii oxido, turns arsenic to ferrous arsenate which is insoluble. Ferric hydrate may be hurriedly prepared by precipitating solution of ferric sulphate with magnesia. The two solutions should be kept in separate bottles, and when needed they may be mixed and administered.
k—Opium
1—Potassium permanganate and tannic acid
l—Strychnin ($C_{21}H_{22}N_2O_2$)
Antidote
Tannic acid.
Test
Acidify and draw through the solution a

crystal of potassium bichromate; a play of colors results.

m—Phenol

Antidote

Alcohol; stomach pump; magnesium or sodium sulphate; sodium carbonate; demulcents; atropin; amyl nitrite; nitroglycerin.

n—Alkalis

Antidote

Vegetable acids diluted, vinegar, lemon juice, albumen, milk, oils, stimulants.

o—Alkaloids

Antidote

Potassium permanganate, albumen, tannin, charcoal.

p—Iodin

Starch, flour, albumen, emetic, amyl nitrite, morphin.

q—Opium and Morphin

Tannic acid, emetic of 20 grains of sulphate of zinc, or stomach pump; apomorphin hypodermically; potassium permanganate is a good antidote if given promptly; atropin hypodermically; coffee or caffein, alternate hot and cold water to nape of the neck; compelling the patient to move about; galvanic shocks; oxygen, artificial respiration, stimulants.

r—Unknown Poison

℞

Liq. ferri sulphatis ...f℥iiss
Magnesiae calcinate ...℥ij
Carbo animalis .....℥i
Water .....℥xx

Dose—℥xx

MEDICAL PHYSICS

DEFINITION

Physics is the science which treats of matter and energy.

A—MATTER

I—Definition

Anything that occupies space and can be apprehended by the senses.

II—Properties
1—Extension
Property of occupying space
2—Porosity
Property of having intermolecular spaces
3—Indestructibility
Property of retaining its ultimate quantity
4—Divisibility
Property of matter to admit of division into smaller particles
5—Gravitation
Attraction that one mass of matter has for another
III—Classification of matter
1—Solid
2—Liquid
3—Gaseous
4—Crookes' Radiant state

B—SOLIDS
I—Definition
Self-subsistent figure
II—Characteristic properties
1—Hardness
Property of resisting displacement of particles
2—Brittleness
Property of being broken easily
3—Tenacity
Property of resisting separation of particles
4—Malleability
Property of being rolled into sheets
5—Ductility
Property of being drawn into wire
6—Expansibility
Property by means of which volume may be increased

C—LIQUIDS
I—Definition
No self-subsistent figure
II—Properties
1—Require a vessel to hold them
2—Present a horizontal surface
3—Attraction of cohesion, acts with less energy, permitting free motion of the particles

D—GASEOUS STATE

I—Definition

No subsistent figure, molecules repel each other

II—Properties

1—Elasticity or tension

The volume of a gas is inverse to the pressure

The density and elastic force are directly as the pressure and inversely as the volume

3—Law of Avogadro

All gases contain, in the same volume, the same number of molecules

4—Law of Charles

Under constant pressure the volume of a gas increases or decreases directly as the temperature. With a constant volume the pressure increases or decreases directly as the temperature

5—Law of Graham's

The velocity of diffusion of different gases is inversely proportional to the square roots of their densities

III—Weight of gases

Fill a glass tube about three feet long with mercury and invert it into a vessel containing mercury. The mercury will drop to a height of 30 inches leaving a vacuum above. The column of mercury is maintained at this height by the pressure of the atmosphere; therefore a column of mercury 30 inches high exerts same pressure as equal column of atmosphere. The weight of a column of mercury having a base of one square inch and height of 30 inches equals 15 pounds; then a column of atmosphere with a base of one square inch must weigh 15 pounds to square inch or one ton to the square foot.

Light

Definition

Light is that form of energy which may be appreciated by the organ of vision.

Color

Light travels 186,000 miles per second, different wave lengths produce different colors; slowest wave produces red, then with increased frequency, orange, yellow, green, blue, indigo, and violet; waves too limited to be visible called infra waves, great heating power. Waves greater frequency than violet called ultra violet or actinic ray; great chemical power.

Electricity

Definition

Manifestation of energy believed to consist in undulations of ether and vibration of the grosser molecules of matter

Electrolysis

Chemical decomposition by electricity

Electrolyte

Substance capable of carrying current of electricity

Ion

Electrically charged element, cations (plus) attracted to cathode or negative pole. Anions (minus) those which go to anode or positive pole

Cations are designated by means of a dot (.)

Example—K

Anions by means of dash or accent (—) (′)

Example—Cl′

Currents

A—Galvanic (Voltaic)

Chemical action, plate of Zn and Carbon joined by wire immersed in H_2SO_4. Current passes from zinc to carbon and the H_2SO_4 is ionized to H and (SO4) ions, H ions pass out at negative pole. Oxygen passes out at positive pole.

Plates may be in

1—Parallel—all zinc attached and all copper attached

2—Series—in which zinc of one is attached to copper plate of another

B—Roentgen or X-Ray

Produced in high vacuum glass tube: the cathode ray, stopped by impact on metallic surface such as platinum

C—Farradic

Interrupted or alternating current produced by induction current into a thin insulated wire surrounding another coil of short thick insulated wire

D—Static

Frictional electricity, Leyden jar condenser used for accumulating a large quantity of electricity

Definitions

A—Volt—unit of electromotive force

B—Watt—electric power of one ampere at one volt

C—Coulomb—unit of current; equals one ampere per second, flowing against one ohm, with force of one volt

D—Ohm—unit of resistance

E—Ampere—current carrying one coulomb per second

F—Milliampere—1/1000 of ampere

For medical purposes 1 to 100 milliamperes given.

Heat

Definition

A form of energy into which other forms tend to be converted which excites peculiar sensations when made to act upon the body; gives rise to luminous phenomena, causes expansion in all bodies and dissociation of their molecules, so as to liquefy solids, evaporate liquids and rarify gases; and produces various chemical changes, particularly oxidation and combustion.

Latent Heat exists

Where heat is added to a body without change in temperature.

Source of Heat

A—Sun
B—Interior of earth
C—Mechanical action
D—Electricity
E—Chemical action

Distillation

Conversion of liquid into gas and condensation of gas into a liquid.

Sublimation

Conversion of a solid into a gas and reconversion back into a solid.

Thermometers

Thermometers are instruments for the measurement of temperature. They are glass tubes having a bulb blown at one end and closed at the other, the bulb and part of the tube being filled with mercury or with alcohol, the contraction or expansion of which indicates a fall or rise of temperature. In every thermometer there are two fixed points. The lower, or freezing point, is fixed by immersing the instrument in melting ice, and marking the level of the mercury in the tube upon the glass. The higher, or boiling point, is fixed by suspending the instrument in boiling water. The instrument is then graduated according to one of three scales: the Celsius, or Centigrade, the Fahrenheit and the Reaumur. The freezing point is marked 0° in the Centigrade and Reaumur scales, and 32° in the Fahrenheit. The boiling point is marked 100° in the Centigrade, 212° in the Fahrenheit and 80° in the Reaumur scale. The space between the fixed points is divided into 100 equal degrees in the Centigrade scale, into 180° in the Fahren-

heit, and into 80° in the Reaumur. To convert the readings of one scale into terms of the other

C° = 5/9 of F° — 32

F° = 9/5 of C° + 32

R° = 4/5 of C°

Specific Heat

Heat required to raise certain weight of substance to certain degree compared to equal weight of water. Unit equals that required to raise 1 gram of water 1 degree Centigrade, called a calore

Conduction of Heat

Direct transfer of molecular motion, called conduction of heat

Hygrometer

Instrument to measure moisture in air, composed of two thermometers (wet and dry) called psychrometers. Dry bulb indicates temperature of air, wet bulb gives temperature of evaporation (dew point)

Definitions

1—Weight

A—Definition

Expression to denote measure of force of gravitation.

1—Troy or apothecary

2—Avoirdupois

3—Metric

A—Unit of linear measure—Meter

Equal to 39.37 inches divided into ten parts called centimeters, each centimeter again divided into 10 equal parts called millimeters

B—Unit of capacity—Liter

The cube of a decimeter; contains 1,000 centimeters; equal to a quart.

C—Unit of weight—Gram

Weight of a cubic centimeter of water at 4 degrees Centigrade

2—Specific Gravity or Weight

Definition

Relative weight of equal volume of substances, one being used as standard

Unit of measure for solids and liquids

Pure water at 4 degrees Centigrade and a barometric pressure of 760 mm. The

specific gravity of solids and liquids is taken at a temperature, 15.5 degrees C.

Unit for gases

Hydrogen at zero degree Centigrade and 760 mm. pressure.

Estimation of Specific Gravity

a—Solids

Solids heavier than water

Weigh substance in air and then in water, divide weight in air by loss of weight in water

Example

Weight in air .....A
Weight in water .....B
Loss of weight in water (weight of volume of water displaced) .C
Then A ÷ C = Specific gravity

Solids lighter than water

First weigh it in air then in water with a sinker attached. The specific weight of the sinker is then determined and subtracted from that of both. The specific gravity is calculated as before

Solids soluble in water

The specific gravity is determined in a liquid having no solvent action, the specific gravity of which is known, and the weight of a corresponding volume of water is calculated

b—Liquids

Weigh equal volumes of water and the given liquid and divide the latter by the former

The *pyknometer* is a flask of thin glass, holding accurately when completely filled a given volume at a definite temperature. It is used for determining specific gravity of fluids

The *hydrometer* is an instrument used also for this purpose, and is made of glass tubing, weighted below to maintain it upright when floating, and with a stem above showing a scale. Sinks in water to a mark on a scale—usually 1—and the other marks show the specific gravity of the fluid according as the instrument floats above or below or at this level

c—Gases

Of gases—by the specific gravity bottle, then divide the weight of its molecule by two

3—Types of Attraction

A—Capillary attraction

Attraction of surface of tube for liquid

Example

If a piece of glass is placed in water the liquid will rise along the side of the glass

B—Attraction of gravitation

Attraction the earth has for all substances upon its surface

Example

Falling of fruit from trees

C—Attraction of adhesion

Attraction of dissimilar molecules

Example

Place a piece of chalk in water; it becomes wet

D—Attraction of cohesion

Attraction between similar molecules

Example

A piece of chalk

4—Force

Action of one body upon another tending to produce change or arrest motion

5—Energy

Capacity for doing work

a—Potential

Energy of position

b—Kinetic

Energy of motion

6—Amorphous substance

Solid substance without crystalline structure

7—Evaporation

Passing of a liquid into a gaseous state

8—Filtration

Separating a liquid from a solid by a porous membrane

9—Saturation

Incapacity of a liquid to retain any more of a given substance in solution

10—Dialysis, or Osmosis

Separation of a crystalloid from a colloid by placing them upon an animal membrane; that which passes through called

crystalloid; that which remains on membrane called colloid

11—Effervescence

Passage of a gas through a liquid

12—Efflorescence

Power to give off water of crystallization

13—Deliquescence

Taking up water from air

14—Solution

A liquid in which a solid is dissolved

15—Precipitate

A solid substance thrown out of solution

16—Fluorescence

Power to lower refractibility of light rays so as to convert ultra violet into visible violet rays, *i.e.* Quinin

17—Crystalline substances

Solid substances bounded by plane surfaces symmetrically arranged according to fixed laws

a—A polymorphous substance is one that can crystallize in more than one form

b—Isomorphous substances are different substances which will crystallize in forms identical with each other

18—Destructive distillation

Decomposition of non-volatile substances by heat with exclusion of air

19—Smelting

Process of obtaining a metal from its ore by fusion

SECTION V

ANATOMY

HISTOLOGY

DEFINITION

The science which treats of microscopic anatomy

CELL

Definition

The microscopic structural unit of the body

Description

It is composed of protoplasm surrounded by a membrane called the cell wall; within the cell wall is a spongy network called spongioplasm. This contains a hyaline substance called hyaloplasm; also foreign particles called deuteroplasm

Nucleus

A highly refractile body in the cell

It shows for inspection

1—Nuclear membrane: membrane surrounding the nucleus

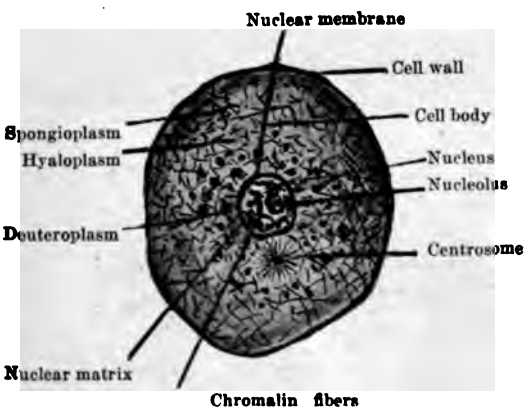


FIG. 40.—Typical Cell

2—Nuclear network: strongly staining filaments in the nucleus; and thickenings called nodal enlargements

3—Nuclear matrix: a transparent gelatinous semifluid substance occupying the spaces between the filaments

4—Nucleolus: a small spherical body in the nucleus; it transmits the hereditary characteristics

5—Centrosome: situated in the nucleus, surrounded by clear area and controls reproduction

Physiology

1—Metabolism

2—Growth

3—Reproduction

4—Irritability
5—Motility
6—Conductivity

Origin

All human cells are derived from the female ovum, which undergoes a process of segmentation and divides into three layers

A—Ectoderm or Epiblast from which is derived
- a—Epithelium of the skin
- b—Skin appendages
- c—Nervous system

B—Mesoderm or Mesoblast from which is derived
- a—Connective tissues
- b—Areolar tissue
- c—Tendons
- d—Cartilage and bone
- e—Dentin of teeth
- f—Muscular tissue
- g—Sexual organs
- h—Genito-urinary system
- i—Vascular system

C—Entoderm or Hypoblast from which is derived
- a—Glandular epithelium
- b—Alimentary canal
- c—Notochord

Specialization

A change in shape to perform a special function

Multiplication

1—Direct division

Least common; constriction in the cell, increases until the cell divides

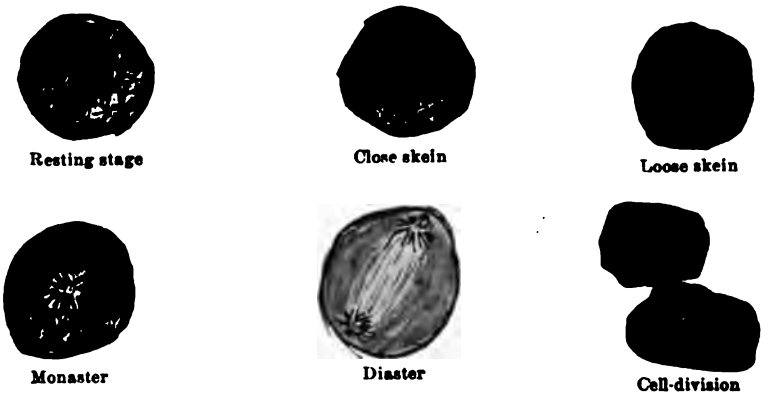


FIG. 41.—Stages—Cell Division

2—Indirect, Karokinesis, Mitosis
A—Close skein stage
The centrosome leaves the nucleus and divides into halves which travel to opposite poles of the cell; nuclear network in fine close skein
B—Loose skein stage
Chromatic fibrils less closely woven
C—Monaster stage
Chromatic fibrils break up into V-shaped bodies called chromosomes, apex to the center
D—Diaster stage
Centrosome divides, each half traveling to opposite pole.
E—Cell division
Division of nucleus and cell
Time required, one-half hour

TISSUES

Definition
A collection of similar cells, having a common function
Classification
1—Epithelial
2—Nervous
3—Muscular
4—Vascular
5—Connective
Description
1—Epithelium
Definition
Cellular tissue characterized by intercellular substance of cement nature
Classification
a—Shape of cells
Squamous
Thin scales; ovoid; polygonal or stellate.
Columnar
Cylindric, prismatic, cuboid, pyriform, fusiform, goblet-shaped, or ciliated
b—Arrangement of cells
Pavement, transitional, stratified
c—Function of cells
Protective, on the skin
Propulsive, in the fallopian tubes
Conductive

Secretory, in the glands
Absorptive, in the alimentary tract
Nervous (neuro-epithelium), in the internal ear

Description

a—Squamous cells

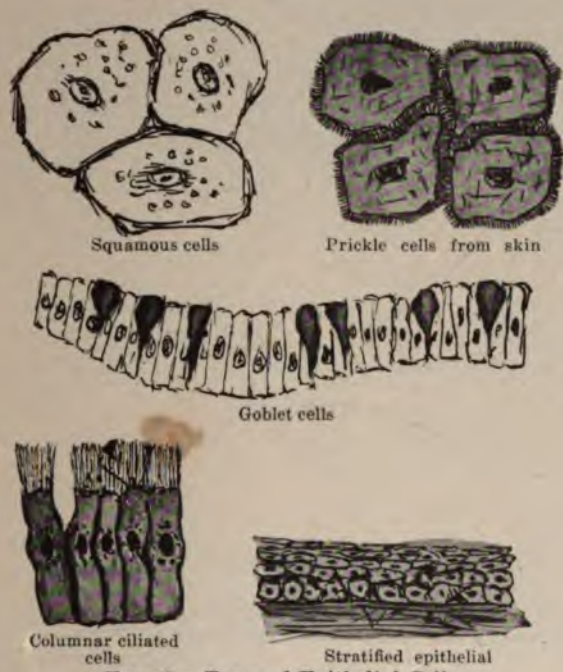


FIG. 42.—Types of Epithelial Cells

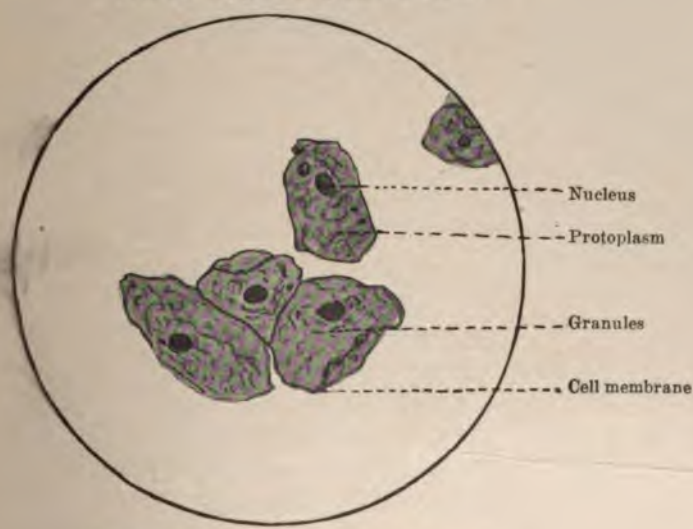


FIG. 43.—Epithelium, Simple Squamous

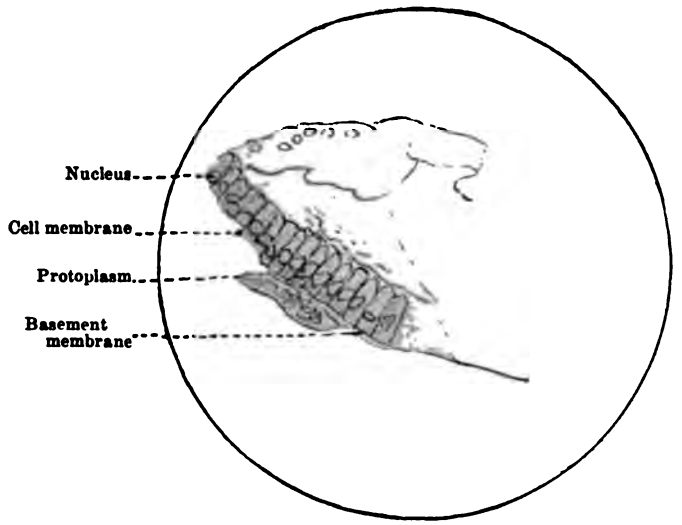


FIG. 43a.—Epithelium, Simple Columnar

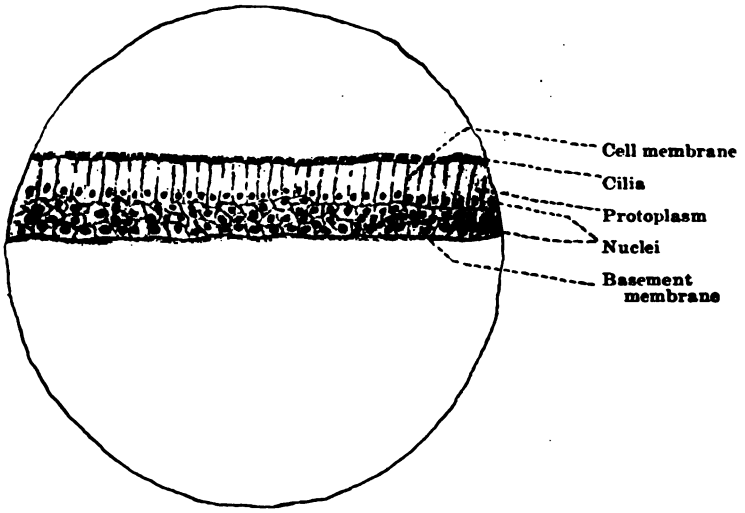


FIG. 44.—Stratified Columnar Epithelium, Ciliated

Thin, flattened; as in the skin and mucous membranes

b—Columnar

Longer than broad, may be cylindric, prismatic or cuboid; occasionally covered with hair-like processes called cilia; found in the fallopian tubes, nasal fossae and bronchi

c—Pavement epithelium

Single layer on a basement membrane

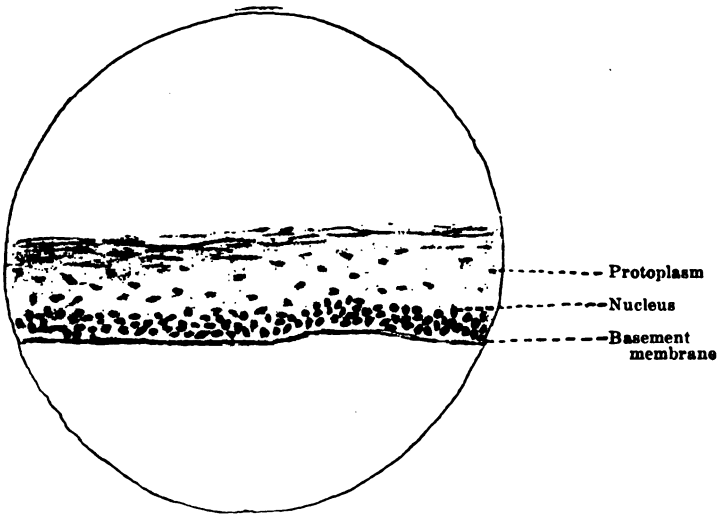


FIG. 45.—Stratified Squamous

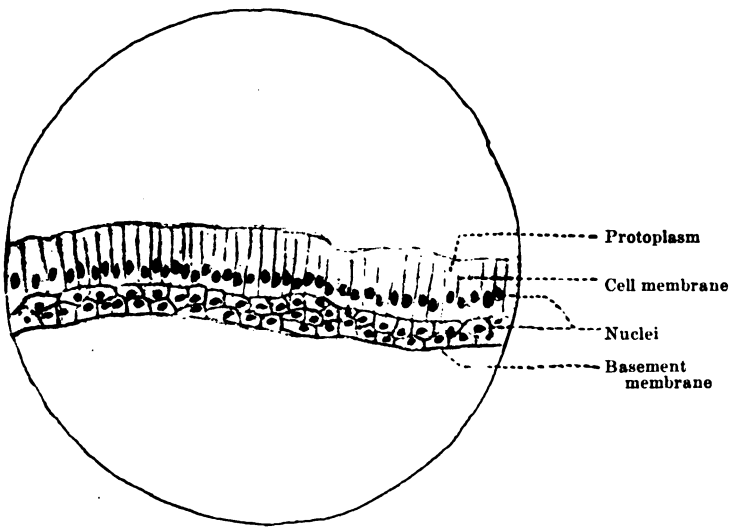


FIG. 46.—Stratified Columnar

d—Stratified

Arranged in many superimposed layers

e—Transitional

Modified stratified in which a change from one type of cell to another is taking place

2—Nerve tissue

Definition

A nerve cell with all its processes is called a neuron

Cells

Large, with a well marked nucleus; the cytoplasm contains chromatophilic granules. Classified as to processes into unipolar, bipolar and tripolar cells

Axis cylinder, a process which does not divide, given off from one end of the cell; it gives off side issues called collaterals

Dentrite, a process from the other end of the cell which branches like a tree

Fibers

A—Medullated or white; consists of a thread-like axis cylinder, surrounded by fatty material (myelin) called secondary sheath or white substance of Schwann; the sheath is surrounded by a membrane called the neurilemma; at frequent intervals the neurilemma dips down to the

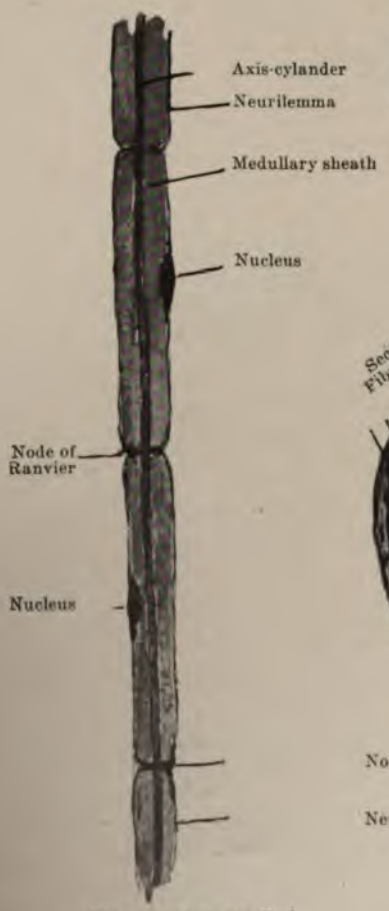
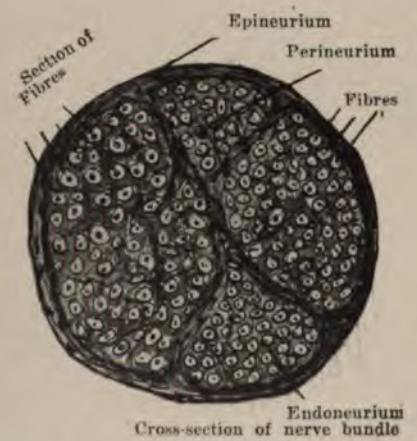


Diagram of single fibre (Longitudinal)



Cross-section of nerve bundle

FIG. 47.—Nerve

axis chamber to form nodes of Ranvier. Under the neurilemma are nuclei. The entire nerve is held together by the epineurium; a fasciculus is held together by the perineurium; each nerve fiber is held to its fellow by the endoneurium. The nerve cells are held together by a special type of connective tissue called neuroglia

B—Non-medullated (Gray or Remak's); have no medullary sheath; found principally in the sympathetic system

Ganglia

Fusiform enlargements in the course of a nerve, containing nerve fibers and cells and having one afferant and one efferant nerve fiber

Nerve endings

A—Terminal plexus

Formed in the skin, mucous membranes and cornea

B—End organs

Tactile cells

Compound tactile cells

a—Corpuscles of Meissner in the skin

b—Pacinian corpuscles (Vater) in the fingers and toes, mouth, nose, eyes and genitals

c—End bulbs of Krause, in conjunctiva

d—Genital corpuscles

C—Nerve endings in non-striated muscles

Non-medullated, derived from the sympathetics; form arborization about the muscle

C—Nerve endings in non-striated muscles

Sensory fibers, which form a network between muscle fibers, while motor nerves enter the fibers

E—Nerve endings in tendons

a—Dilated bulbs

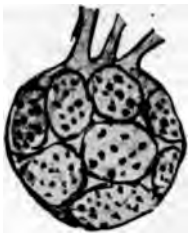
b—Tendon spindles

3—Muscles

Definition

Specialized tissue possessing contractility to a great degree

Papilla of the hand



Genital corpuscle (Clitoris)

Corpuscle of Vater Pacinian body from Mesentery

FIG. 48.—Nerve Endings in Voluntary Muscle

Description

a—Striated (Voluntary or skeletal)

Composed of cylindrical fibers ¾ to 1½ inches long, 1/500 inch wide; each fiber covered by sarcolemma, beneath which are situated nuclei. The fiber shows cross striations, alternating light and dark bands: a dark line (membrane of Krause) in the center of a light band and a lighter line (median line of Hensen) in the center of a dark band; these striated bands are called sarcostyles. In cross section each fiber appears divided into dark areas outlined by bright matter; these are called areas of Cohnheim. Individual fibers are held together by connective tissue called endomysium, the fasciculi by perimysium, and the entire muscle by epimysium

b—Smooth muscle (nonstriated, involuntary)

Spindle-shaped fibers, 1/250 inch in length, 1/5000 in width; covered by a fine sheath; in

the center is a rod-shaped nucleus; the fibers are held together by a cement-like substance and by interlacing of fibers

c—Heart muscle

Rectangular branching cells, striated and involuntary; a single nucleus in the center of the cell

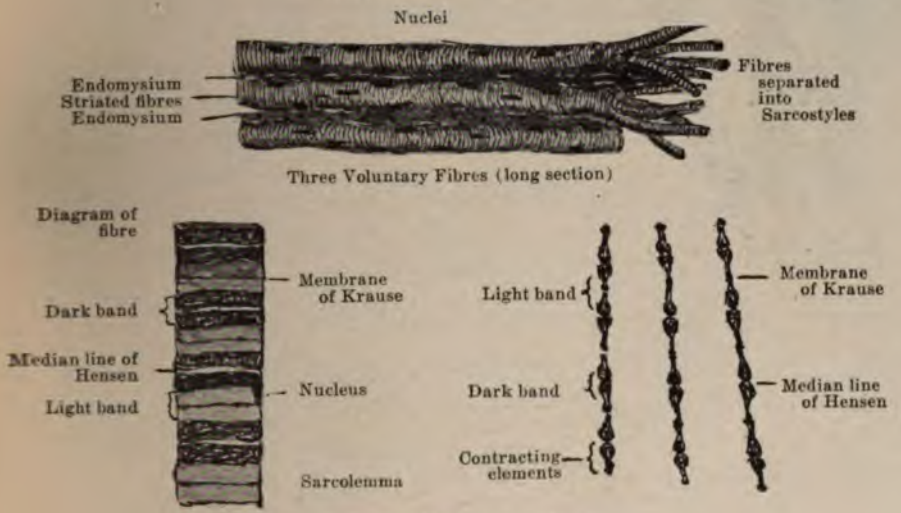


FIG. 49.—Voluntary Muscle

FIG. 50.—Smooth (Involuntary) Muscle-fibres

FIG. 51.—Heart Muscle

d—General Characteristics—Summary

Voluntary

A—Fibers long, ¾ to 1½ inches
B—Fibers cylindric
C—Fibers striated
D—Fibers contain many nuclei
E—Fibers contain nuclei at the edge
F—Nuclei are oval
G—Fibers are united by fibrous tissue called endomysium, perimysium, and epimysium, according to location

Smooth

A—Fibers shorter, 1/250 of an inch
B—Fibers fusiform
C—Fibers unstriated
D—Fibers contain nucleus at center
E—Fibers contain one nucleus
F—Nuclei are elongated and rod-shaped
G—Fibers are united by a cement-like substance, interlacing of ends, and intercellular spiculae

Heart

A—Fibers are rectangular
B—Fibers are cross-striated
C—Fibers are united by branching and by a cement-like substance

4—Blood vessels

A—Arteries

a—Tunica Intima (inner serous coat): a single layer of endothelial cells on a basement membrane, surrounded by a layer of wavy elastic tissue called fenestrated membrane of Henle

b—Tunica Media: consists of smooth muscle running circularly around the artery; also white fibrous and yellow elastic tissue

c—Tunica adventitia: white fibrous and yellow elastic tissue

B—Veins

Walls thinner than those of the arteries and contain less muscle tissue; on cut section, they collapse

c—Capillaries

Single layer of endothelial cells on a basement membrane

D—Heart

a—Endocardium or inner coat: a single layer of endothelial cells on a basement membrane; reduplication forms the valves

b—Myocardium: middle (muscular) coat

c—Epicardium: visceral layer of pericardium; a single layer of endothelial cells on a basement membrane

E—Blood

(*See* Physiology)

5—Connective tissue

A—Areolar

Tissue composed of white fibrous, yellow elastic and adipose tissue

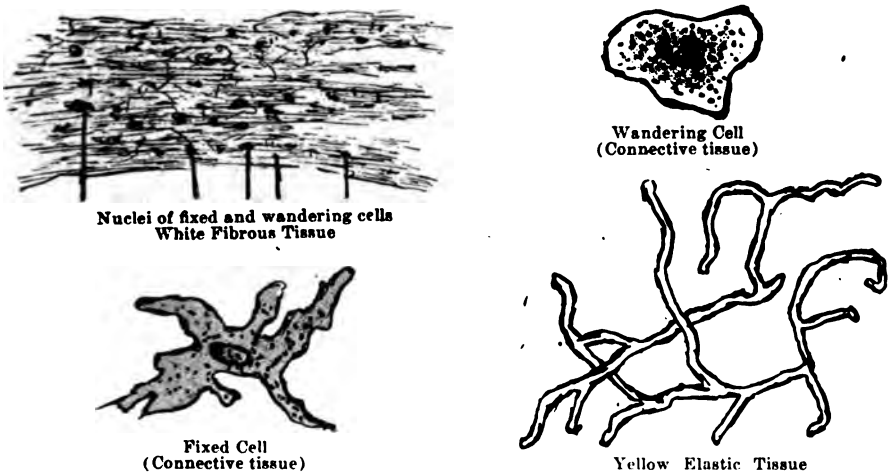


FIG. 52.—Connective Tissue and Cells

B—Mucous

Large branching cells, surrounded by mucin, found in the vitreous humor of the eye

C—White fibrous

Delicate fibrils which run parallel and unite in a bundle; contain two kinds of cells; wandering cells from the blood and fixed connective tissue cells, the fibroblasts. This tissue forms a frame work for all the organs of the body

D—Tendons

Strong fibrous cords serving to unite the muscle to the bone; composed of secondary bundles continuous with the fibrous investment of the muscle. These contain

large irregular tendon cells

E—Yellow elastic

Branching fibers under tension; when broken they curl up. These are found in the ligamentum nuchae only

F—Adipose tissue

Large clear spheroidal cells, known as fat cells; supported by white fibrous tissue; the nucleus of the cell

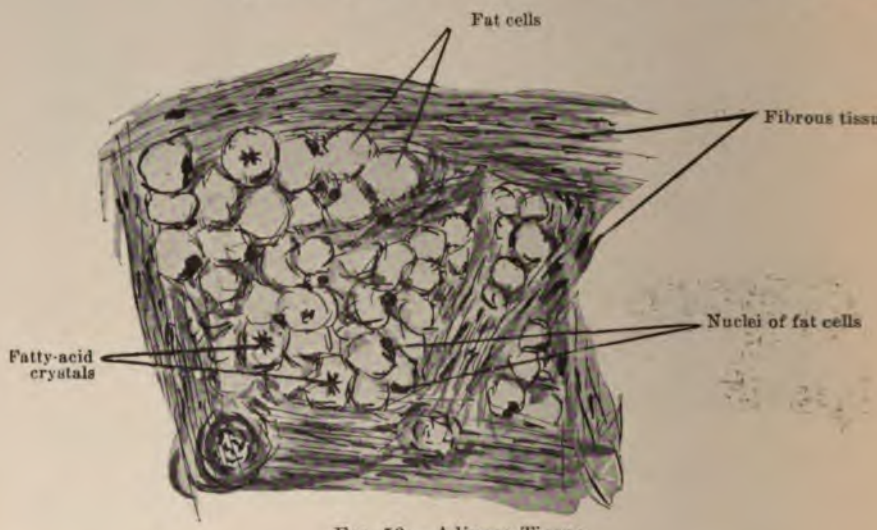


FIG. 53.—Adipose Tissue

is pushed to one side and contains fatty acid crystals (margarin)

G—Retiform

Fine reticulum of fibrous tissue

H—Adenoid

Retiform tissue, with small round lymphoid cells entangled in its meshes

I—Cartilage

a—Varieties

1—Hyaline

2—Yellow elastic

3—White fibrous

b—Perichondrium

Membrane that surrounds all forms of cartilage. It is composed of an outer or fibrous layer and an inner or cellular layer containing connective tissue cells

FIG. 54.—Adenoid Tissue, Lymphoid Cell

c—Hyaline Cartilage

Firm, translucent opalescent substance called matrix; surrounded by a dense substance called a capsule; scattered throughout the matrix are spaces called lacunae; within the lacunae are found cartilage cells

Hyaline cartilage contains no blood vessels or lymphatics. It occurs in the trachea and Eustachian tubes

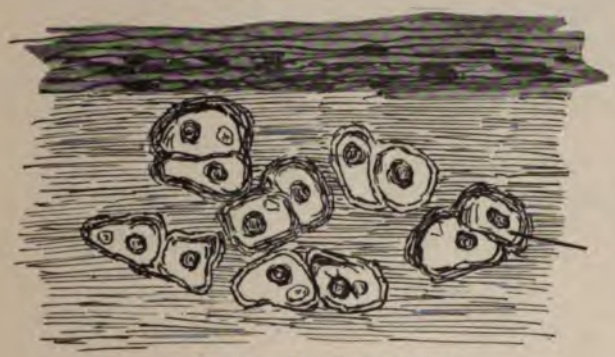


FIG. 55.—Hyaline Cartilage

d—White fibrous Cartilage

Hyaline cartilage, having bundles of white fibrous tissue coursing through it. Found in the symphyses and intervertebral disks

FIG. 56.—White Fibro-cartilage

e—Yellow elastic Cartilage

Hyaline cartilage with yellow elastic bands extending through the hyaline substance. Found in cartilages of the larynx

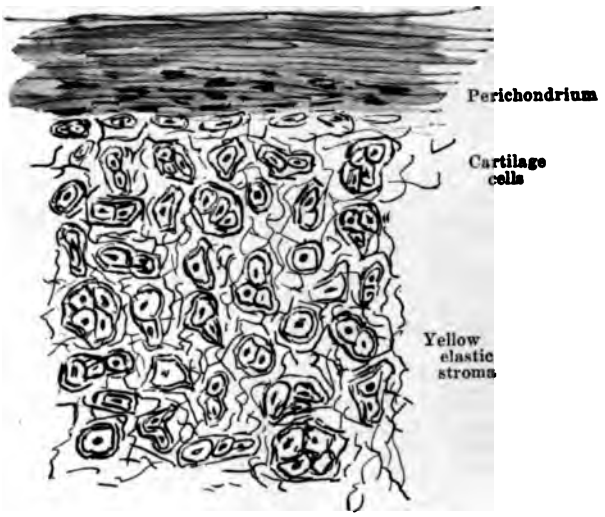


FIG. 57.—Yellow Elastic Cartilage

J—Bone

a—Classification

Compact (hard)

Cancellous (spongy)

b—Periosteum

Covering of bone; outer layer fibrous, inner layer cellular, called osteogenetic layer

c—Compact bone

An inner (medullary) and outer (periosteal) condensation of calcium salts called circumferential lamellae. Between the two lamellae is situated the Haversian system composed of

A—Haversian canal

B—Lacunae

C—Canaliculi

Its function is nutrition of the bone. Between the Haversian systems is another set of canals, called Volkmann's canals

d—Spongy or Cancellous bones

Composed of spicules of bone arranged to form spaces containing bone marrow

FIG. 58.—Bone Transverse Section

A—Red marrow contains a delicate reticulum, characterized by
a—Myelocyte, a moderate sized cell with a single nucleus containing granules
b—Erythroblasts, red cells with a nucleus
c—Eosinophiles, cells containing eosinophilic granules
d—Basophiles, cells taking a basic dye
e—Giant cells, cells containing many nuclei

B—Yellow marrow, same as red, except that it contains more fat cells and less red cells

e—Development
Two methods
A—Cartilaginous; *e.g.*, bones of limbs, vertebral column, sternum, ribs, base of skull

B—Intra-membranous; *e.g.*, roof of skull, bones of the face and lower jaw

Bones

Grow in length by intracartilaginous method and in thickness by intra-membranous ossification

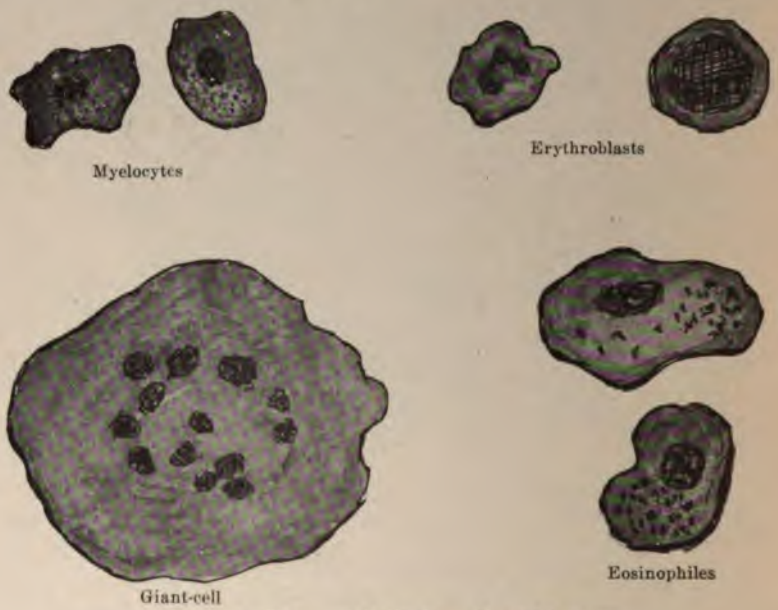


FIG. 59.—Types of Cells from Bone Marrow

Description

A—Intracartilaginous ossification

In a long bone ossification begins in the center of the bone; later other centers appear, which form the epiphysis. The processes by which bone succeeds cartilage are as follows

a—The cartilage at the center of ossification becomes permeated with vessels and osteoblasts derived from the inner layer of the periosteum

b—In the neighborhood of the vessels the cells are arranged in radiating columns

c—The matrix between the columns of the cells becomes permeated with lime salts, extending between and around cell groups and enclosing

them in spaces called the primary areolae, in which osteoblasts, marrow cells and vessels replace the cartilage cells

d—The osteoblasts arrange themselves on the surfaces of the walls of the cavities and gradually form bone-substance with lamellae, Haversian canals and lacunae. Thus a spongy or cancellous tissue is formed, the calcified matrix disappears and many of the spaces open into one another

e—Simultaneously with the changes in the cartilage matrix a layer of osseous substance has been formed beneath the periosteum, which continues to increase in thickness, being deposited around the osteoblasts and finally compact bone is formed

f—The spongy bone formed as described is not permanent, the greater part of it being absorbed to form the medullary cavities. At birth the compact tissue which surrounds the shaft has been formed from the periosteum, while the cancellous tissue at the ends of the bone and elsewhere has been formed from the cartilage.

g—The absorption of the walls of the primary areolae (the calcified matrix) is effected by certain cells termed osteoclasts, or the myeloplaxes of Robin. They are situated in depressions or pits called Howship's Lacunae

B—Intramembranous ossification

In certain bones (named above) development proceeds direct from membrane as in periosteal ossification, without the intervention of cartilage. The matrix, like the periosteum, is made up of layers of fiber tissue, with large nu-

cleated cells (osteoblasts) and blood vessels. By deposition of lime salts around the osteoblasts and blood vessels, bone substance, at first more or less spongy, is formed. The membrane or matrix in which ossification proceeds, consists of indistinct fibers and ground substance densely packed with large granular corpuscles

OSTEOLOGY

A—CLASSIFICATION

I—As to shape

1—Long 90

For support and leverage

Clavicle	2
Three of upper extremity on each side	6
Metacarpal	10
Three of lower extremity on each side	6
Metatarsal	10
Phalanges (hands and feet)	56
	90

2—Short 30

Great solidity, limited motion and compactness

Carpal on both sides	16
Tarsal on both sides	14
	30

3—Flat 40

Protection and muscular attachment

Skull

Occipital	1
Frontal	1
Parietal	2
	4

Face
Nasal 2
Lachrymal 2
Vomer 1

5

Scapula 2
Sternum 1
Ribs 24
Os innominatum 2
Patella 2

40

4—Irregular 40
Spine
Vertebra 24
Sacrum 1
Coccyx 1

26

Skull
Temporal 2
Ethmoid 1
Sphenoid 1

4

Face
Superior Maxilla 2
Zygoma (Malar) 2
Palate 2
Inferior turbinate 2
Mandible (Inferior maxillary) 1

9

Hyoid Arch
Hyoid 1

40

II—As to location
1—Head 22
Cranial
Frontal 1
Parietal 2
Occipital 1

Ethmoid 1
Sphenoid 1
Temporal 2

8

Face

Vomer 1
Mandible 1
Lacrimal 2
Zygoma (Malar) 2
Maxilla (Superior Maxillary). 2
Palate 2
Inferior Turbinate 2
Nasal 2

14

2—Trunk 54

Vertebra

Cervical 7
Dorsal 12
Lumbar 5
Sacral 1
Coccygeal 1

26

Hyoid 1
Ribs 24
Sternum 1
Os innominate 2

28

3—Upper Extremity 64

Shoulder

Scapula 1
Clavicle 1

2

Arm

Humerus 1

Forearm

Radius 1
Ulna 1

2

Hand
- Carpus
  - Navicular (Scaphoid)... 1
  - Lunate (Semilunar) 1
  - Triquetrum (Cuneiform) 1
  - Pisiform 1
  - Greater multangular (Trapezium) 1
  - Lesser multangular (Trapezoid) 1
  - Capitate (Os Magnum) 1
  - Hemate multangular (Unciform) 1

  8
- Metacarpal 5
- Phalanges 14

32 times 2 = 64

4—Lower Extremity 60
- Thigh
  - Femur 1
- Leg
  - Tibia 1
  - Fibula 1
  - Patella 1

  3
- Foot
  - Tarsal
    - Calcaneus (Os calcis)... 1
    - Talus (Astragalus)..... 1
    - Cuboid 1
    - Navicular (Scaphoid)... 1
    - 1st Cuneiform (Inner cuneiform) 1
    - 2nd Cuneiform (Middle cuneiform) 1
    - 3rd Cuneiform (Outer cuneiform) 1

    7
  - Metatarsal 5

Phalanges 14

30 times 2 = 60

TOTAL 200

CRANIAL BONES

OS OCCIPITALE (OCCIPITAL BONE)

Definition

Flat bone situated on posterior and inferior surface of cranium

Examination

1—Outer surface

Convex in shape

Shows

a—Occipital protuberance for ligamentum nuchae

b—Occipital crest, bony ridge from protuberance to foramen magnum

c—Supreme nuchal, superior nuchal, inferior nuchal lines (curved lines)

d—Foramen Occipitale Magnum (Foramen magnum) for spinal cord and membranes, spinal accessory nerve and vertebral artery

e—Condyles, for articulation with atlas

f—Hypoglossal canal (anterior condyloid) foramen, for hypoglossal nerve

g—Condylar canal (posterior condyloid) foramen, transmits a vein to lateral sinus

h—Jugular process, outer side of condyle

i—Basilar (process), articulates with sphenoid

j—Pharyngeal tubercle (spine), bony projection from basilar process for superior constrictor

2—Inner surface

Concave and divided into four fossae by two crucial ridges of bone; at intersection these form internal occipital protuberance. Upper division of crucial ridge forms superior angle of occipital bone and is deeply grooved for sagittal sulcus (superior longitudinal sinus)

3—Borders

A—Superior border articulates with parietal bones, thus forming (lambdoidal) suture

B—Inferior border articulates with temporals and helps to form jugular foramen

4—Angles

A—Superior angle

Helps to form posterior fontanelle

B—Inferior angle

Is formed by basilar process and articulates with sphenoid

C—Lateral angles

Received by parietal and temporal bones

Articulation

Six bones

Atlas	1
Sphenoid	1
Temporal	2
Parietal	2
	6

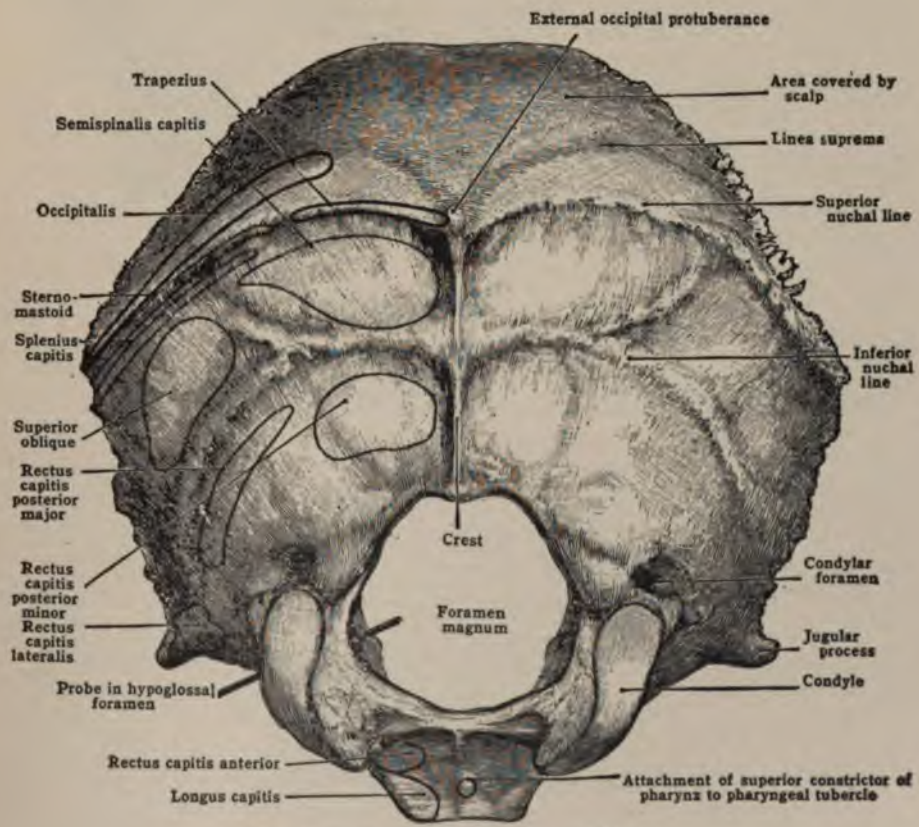


FIG. 60.—The Occipital (External View)

Development: Centers of ossification
1—One center for posterior occipital portion
2—Two centers for condyles
3—One center for basilar process

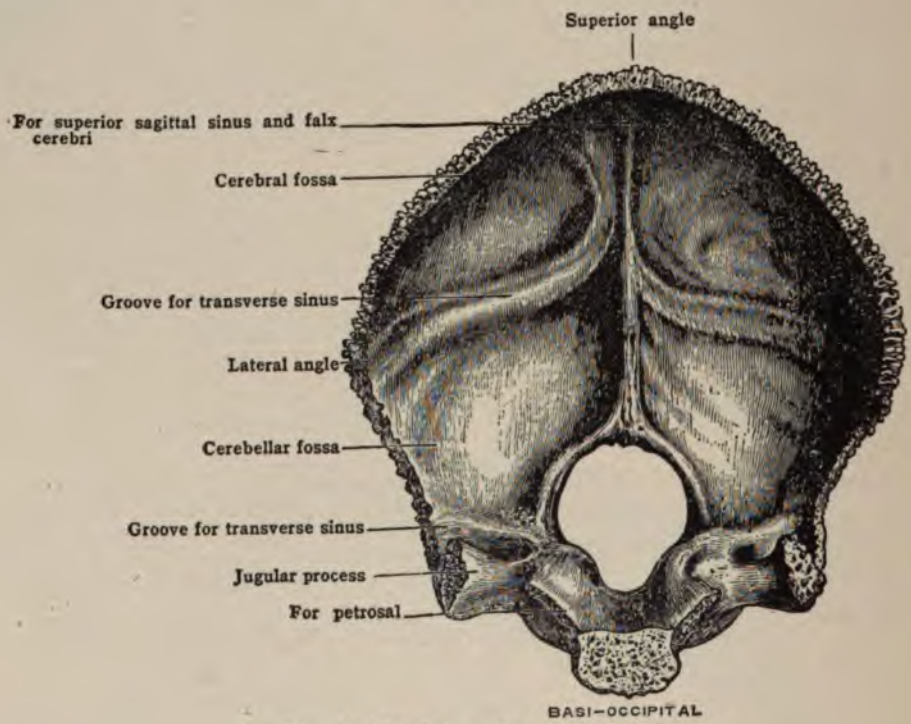


FIG. 61.—Occipital Bone (Cerebral Surface)

OS SPHENOIDAL (SPHENOID)

Definition
Irregular bone enters into formation of
Five cavities
a—Cranium
b—Orbit—2
c—Nasal—2
Four fossae
a—Temporal
b—Infratemporal (zygomatic)
c—Inferior orbital (sphenomaxillary)
d—Pterygo-palatine (pterygomaxillary)
Three fissures
a—Inferior orbital (sphenomaxillary)

c—Pterygomaxillary
c—Superior orbital (sphenoidal)

Examination

1—Body
2—Greater processes
A—Great wing
B—Lesser wing
C—Pterygoid processes
3—Eleven lesser processes
Single
a—Ethmoidal spine
b—Tuberculum sellae (Olivary process)
c—Rostrum
Pairs
a—Posterior clinoid
b—Anterior clinoid
c—Middle clinoid
d—Spinous process

Description

1—Body
A—Upper surface: shows—
Ethmoidal spine for articulation with ethmoid.
Smooth surface
Sometimes grooved for support of olfactory bulbs
Chiasmatic sulcus (optic groove)
Supports optic commissure and leads to optic foramen
Tuberculum sellae (Olivary process)
In front of hypophyseal fossa (sella turcica)
Hypophyseal fossa (pituitary fossa)
For pituitary body; bounded in front by middle clinoid processes
Dorsum Sellae
Floor of fossa and gives off posterior clinoid processes
Sulcus caroticus (cavernous groove)
For basilar (internal carotid) artery and cavernous sinus
B—Anterior surface: shows—
a—Sphenoidal crest (articulates with ethmoid)
b—Opening into sphenoidal sinus
c—Sphenoidal turbinate processes
C—Under surface: shows—
a—Rostrum

Thin plate of bone received into depressio[illegible]
vomer

b—Vaginal process
Articulates with vomer

c—Pterygopalatine groove
Unites with palate to form canalis-phary[illegible]
(pterygopalatine canal), which transmits [illegible]
gopalatine vessel and nerve

D—Posterior surface
Articulates with basilar process of occipital

2—Great Wing

A—Superior surface
Forms middle fossa of skull
Shows

1—Foramen Rotundum, transmits
Superior maxillary nerve

2—Foramen Ovale, transmits
Mandibular (inferior maxillary) ner[illegible]
Small petrosal
Small meningeal

3—Foramen vesalii, transmits
Small emissary vein

4—Foramen spinosum, transmits
Middle meningeal artery

B—External surface
Divided by crista infratemporalis (pterygoid rid[illegible]
into

Superior portion
Helps to form temporal fossae

Inferior portion
Helps to form zygomatic fossae; shows spin[illegible]
of sphenoid for internal Spheno-mandibular
ligament (lateral ligament of mandible)

C—Anterior or Orbital surface
Quadrilateral, assists in forming outer wall of orbit, enters into formation of sphenoidal and spheno-maxillary fissures

D—Circumference
Assists in forming carotid canal, articulates with temporal bone

3—Lesser Wing

A—Upper surface
Smooth; forms part of anterior fossa of skull

B—Under surface

Helps form roof of orbit and upper boundary of superior orbital fissure (sphenoidal fissure)

C—Anterior border

Articulates with frontal bone

D—Posterior border

Forms anterior clinoid processes

E—Optic foramen

Encloses optic nerve

4—Pterygoid processes

Two thin plates of bone, joined anteriorly and enclosing pterygoid fossae

Lamina Lateralis pterygoidei (external pterygoid plate) forms inner wall of zygomatic fossae

Lamina Medialis pterygoidei (internal pterygoid plate) presents, at apex, hamular process

Articulation

Four single

Occipital
Ethmoid
Frontal
Vomer

Four paired

Temporal
Parietal
Zygomatic (malar)
Palate

Centers of ossification

1—Six for posterior ½ of bone

2—Four for anterior ½ of bone

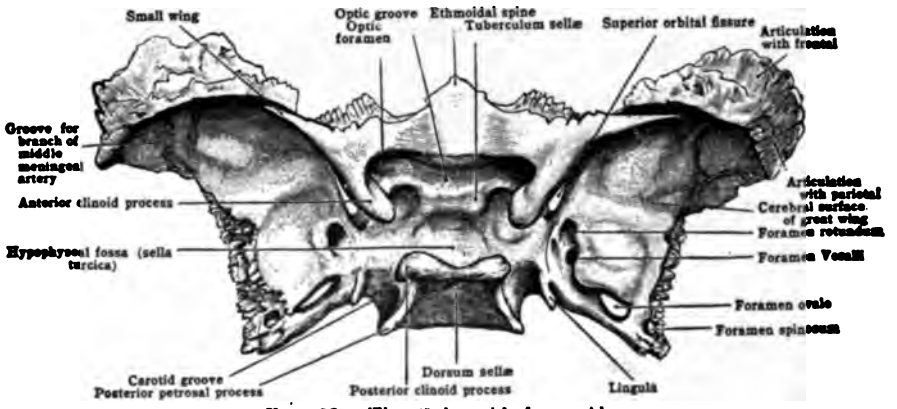


FIG. 62.—The Sphenoid from Above

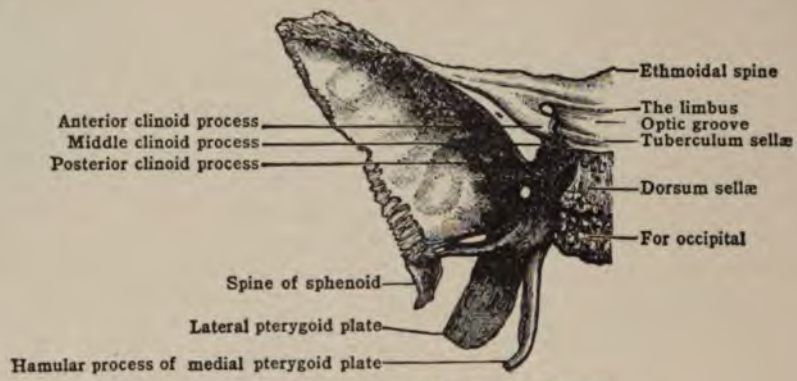


FIG. 63.—The Left Half of the Sphenoid
Morris Human Anatomy (Blakiston)

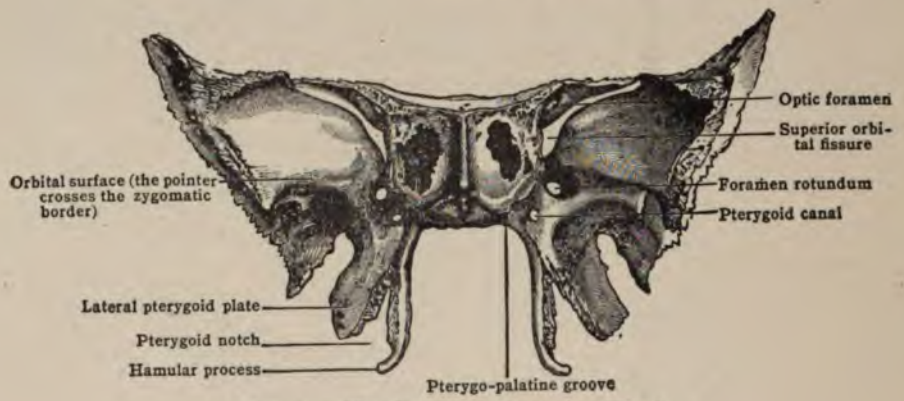


FIG. 64.—The Sphenoid (Anterior View)
Morris Human Anatomy (Blakiston)

OS ETHMOIDALE (ETHMOID)

A—FUNCTION

I—Gives attachment to falx cerebri
II—Small foramen for transmission of olfactory nerve
III—Forms part of septum which separates nasal fossae
IV—Forms superior and inferior concha (turbinated bones)
V—Protection for ethmoid cells

B—HORIZONTAL OR CRIBRIFORM PLATE

Received into ethmoidal notch of frontal bone; forms roof of nose and anterior fossa of skull

1—Crista Galli for attachment of falx cerebri terminates in frontal bone, helps to form foramen caecum

2—Three rows of foramina for olfactory nerves
3—Fissure for nasal branch of ophthalmic nerve

C—PERPENDICULAR PLATE

Helps to form nasal septum; presents labyrinthi ethmoidalis (lateral masses) which enclose irregular shaped cavities called ethmoid cells: anterior and posterior set. Inner surface of lateral masses presents

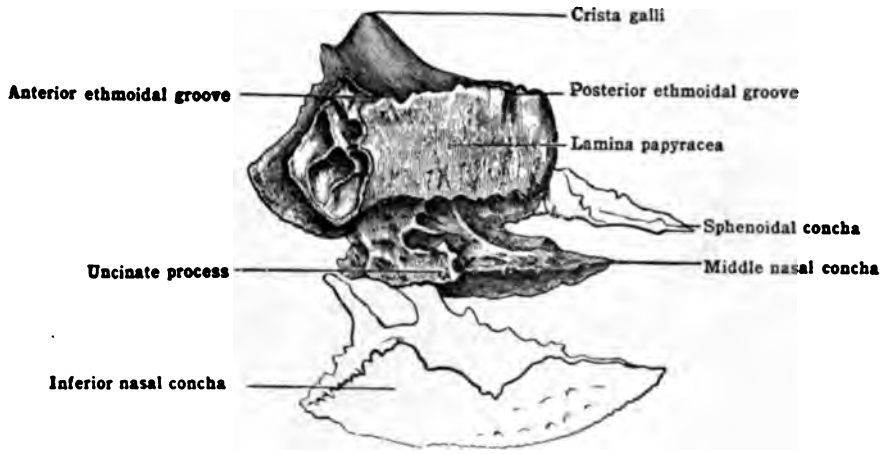


FIG. 65.—The Ethmoid (Lateral View)
Morris Human Anatomy (Blakiston)

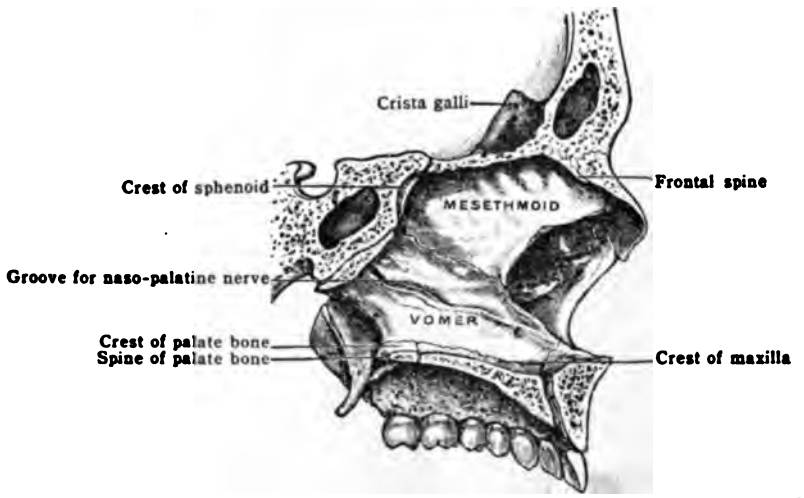


FIG. 65a.—Section Through the Nasal Fossa to Show the Mesethmoid (Lamina Perpendiculars)
Morris Human Anatomy (Blakiston)

1—Superior turbinated process
2—Superior meatus: communicates with posterior ethmoid cells
3—Middle turbinated process
4—Middle meatus
Communicates with anterior ethmoid cells and with frontal sinus

Outer surface
Forms inner wall of orbit: called lamina papyracea (os planum)

Articulates with
All bones of upper jaw except zygoma (malar); supplemented by sphenoid and frontal. No muscle attachment

OS FRONTAL (FRONTAL BONE)

Examination
Shows two portions for examination: frontal and orbitonasal

A—Frontal
Facies frontalis (external surface)
Convex in shape and forms forehead. Presents in medium line a depression, union of lateral halves. Shows nasal eminence, frontal eminences on either side, two ridges called superciliary ridges, inner ½ shows supra-orbital notches

Facies cerebralis (inner surface)
Concave; shows a small foramen called foramen caecum. Frontal crest continued upward in a vertical groove for falx cerebri; laterally shows cerebral impressions for convolutions of brain

Angular Processes
1—Processus zygomaticus (external angular process), broad for articulation of zygomatic (malar) bones; also enters into formation of anterior part of temporal ridge
2—Internal angular process, thin for articulation of lacrimal; shows nasal notch; forms projection called spina frontalis (nasal spine

B—Orbitonasal or Horizontal Portion
Comprises two pars orbitalis (orbital plates), separated by notch in which ethmoidal bone is received (called ethmoidal notch); filled in by cribriform plate of ethmoid

Shows
A—Half cells which close the half cells *of* ethmoid

B—Spinalis frontalis (nasal spine), articulates with perpendicular plate of ethmoid

C—Openings of frontal sinus on either side of spinalis frontalis (nasal spine)

Pars orbitalis (orbital plates)

Under surface

Concave and forms upper wall of cavity of orbit

Shows

Fossa for lacrimal gland

Fossa called trochlearis for superior oblique muscle

Upper surface

Convex, forms floor of anterior fossa

Shows

Cerebral impressions

Articulations

Two single

Sphenoid

Ethmoid

Five pairs

Parietal

Nasal

FIG. 66.—Frontal Bone (Outer Surface)

1, the frontal sulcus; 2, the foramen cæcum, 5, the roof of the orbit; 8, the nasal spine; 10, the internal orbital apophysis; 11, the entrance to the sphenoidal sinus; 12, the external orbital apophysis.

Maxilla (superior maxillary)
Lacrimal
Zygoma (malar)
Ossification, two centers for lateral halves of bones

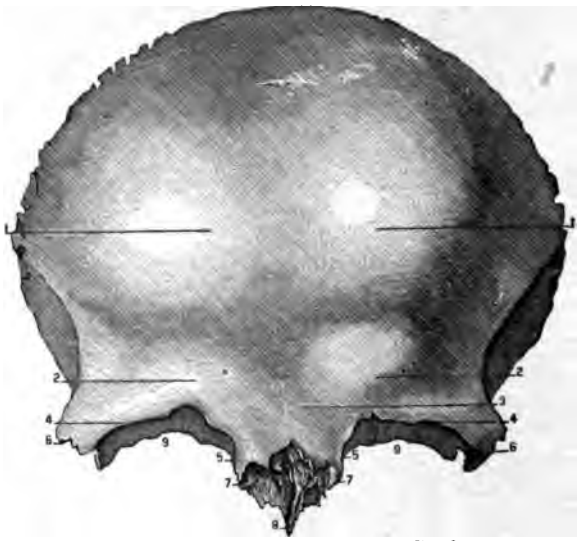


FIG. 66a.—Frontal Bone (Inner Surface)

1, 1, frontal eminences; 2, 2, the superciliary arches; 3, the glabella; 4, 4, the orbital arches; 5, 5, the internal orbital apophyses; 6, 6, the external orbital apophyses; 7, 7, the surfaces for articulation with the nasal and superior maxillary bones; 8, the nasal spine; 9, 9, the roofs of the orbits.

OS TEMPORALE (TEMPORAL)

Divided for description
1—Squamous portion
2—Mastoid portion
3—Petrous portion
A—Squamous portion
Thin, semicircular plate on side of skull
Outer surface
Convex; helps to form temporal fossa
Shows
A—Temporal ridge
B—Zygomatic process; apex articulates with malar bone
C—Fossa mandibularis (glenoid fossa)
Divided into two parts by fissura petrotympanica (glaserian fissure); anterior part is articular, covered with cartilage. Posterior part lodges parotid gland

Inner Surface

Concave, presents cerebral impressions and grooves for middle meningeal artery

Circumference

Articulates with parietal bone and great wing of sphenoid

B—Mastoid

Outer surface

Rough and perforated by many foramina; one of these is large (mastoid foramen) and transmits a vein to transverse sinus (lateral sinus), tip is called mastoid process

Inner surface

Shows incisura mastoidea (digastric groove or fossa incisura mastoidea) and forms part of posterior fossa of skull

C—Petrous Portion

Pyramidal shape, wedged in between sphenoid and basilar process of occipital

1—Base

Shows

a—External auditory meatus

b—Auditory process; bony ring around meatus

2—Apex

Shows

a—Internal carotid canal and forms boundaries of middle lacerated foramen

3—Anterior surface

Shows

a—Internal opening of carotid canal

b—Impressio trigemini (depression for gasserian ganglion)

c—Hiatus canalis facialis (Hiatus fallopi), transmits larger petrosal nerve

d—Foramen for small petrosal nerve

e—Eminentia arcuata (eminence produced by semicircular canal)

4—Posterior surface

Forms anterior boundary of posterior fossa of skull

Shows

a—Meatus auditorius internus

b—Opening of aqueduct vestibuli

5—Inferior or basilary surface

Forms a portion of base of skull

Shows

a—Diagonal line

b—Opening of carotid canal

c—Aqueductus cochlea

d—Jugular fossa

Assists in forming jugular foramen

e—Opening for tympanic branch of glossopharyngeus (Jacobson's nerve)

f—Opening for auricular branch of vagus nerve (Arnold's nerve)

g—Jugular surface articulates with jugular process of occipital

h—Vaginal process, styloidea embraces roots of styloid process of temporal

i—Styloid process

j—Stylomastoid foramen

k—Rough surface

l—Auricular fissure

6—Borders of petrous portion

Superior border, in cavity of skull forms separation between posterior and middle fossae of skull

Posterior border, assists in forming jugular foramen

Articulations

Single

Occipital

Sphenoid

Mandible (inferior maxillary)

Double

Parietal

Zygoma (malar)

Development

Four centers

A—Squamous process and zygomatic

B—Auditory process

C—Petrous and mastoid process

D—Styloid process

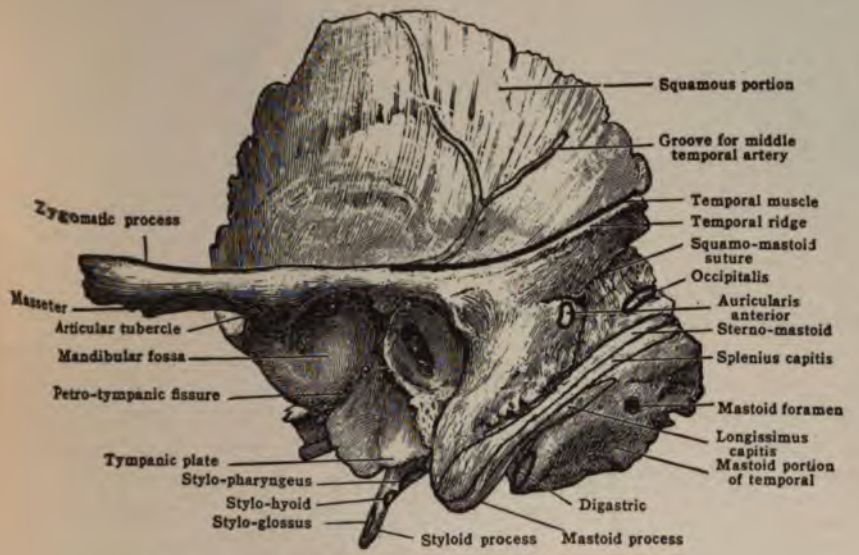


FIG. 67.—The Left Temporal Bone (Outer View)
Morris Human Anatomy (Blakiston)

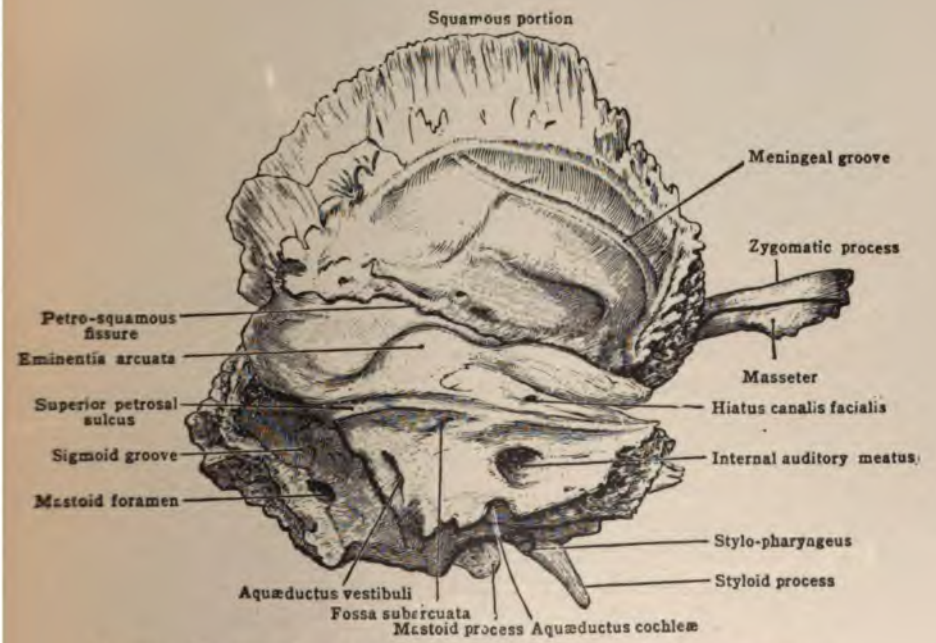


FIG. 68.—The Left Temporal Bone (Seen from the Inner Side and Above)
Morris Human Anatomy (Blakiston)

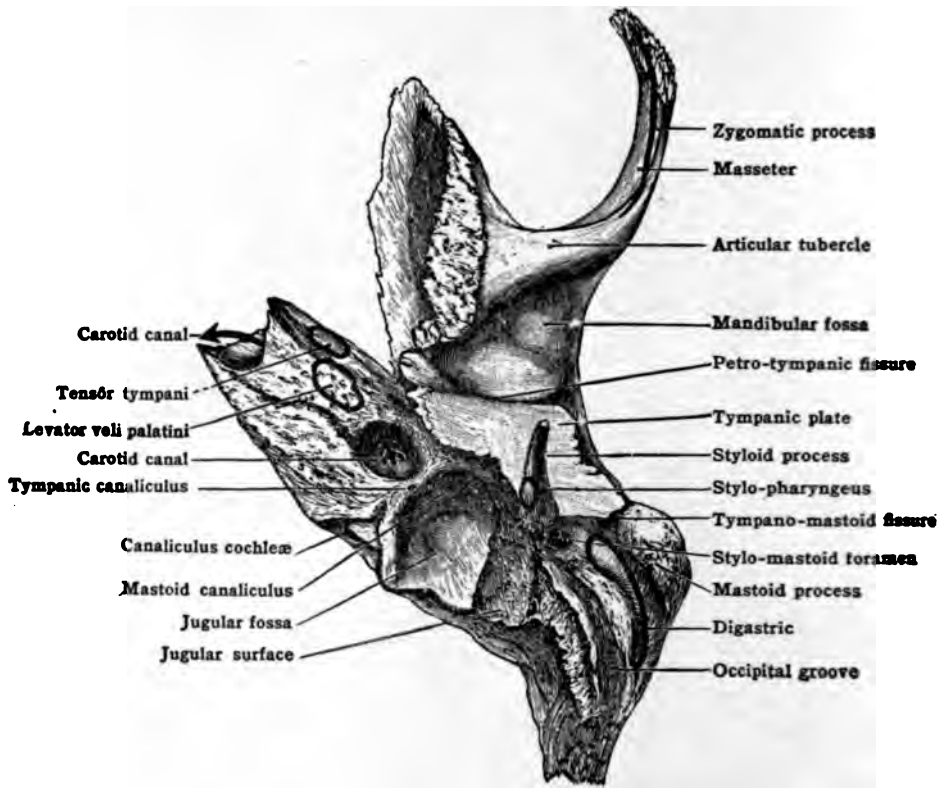


FIG. 69.—The Left Temporal Bone (Inferior View)
Morris Human Anatomy (Blakiston)

OS PARIETALE (PARIETAL BONE)

Forms side of skull

Surfaces

External surface is convex and shows

a—Parietal foramen, in upper and posterior portion of bone

b—Parietal eminence

c—Linea temporalis (temporal ridge) upper boundary of temporal fossa

Internal

a—Cerebral eminences and depressions for convolutions of brain

b—Furrows for middle meningeal artery

c—Sulcus sagittalis (groove for superior longitudinal sinus)

d—Depressions for arachnoid granulations (pacchionian bodies)

Borders

Superior

With opposite fellow forms sagittal suture

Inferior

Articulates with great wing of sphenoid and with squamous and mastoid portions of temporal

Anterior

Articulates with parietal bone to form coronal suture

Posterior

Articulates with occipital bone to form lambdoidal suture

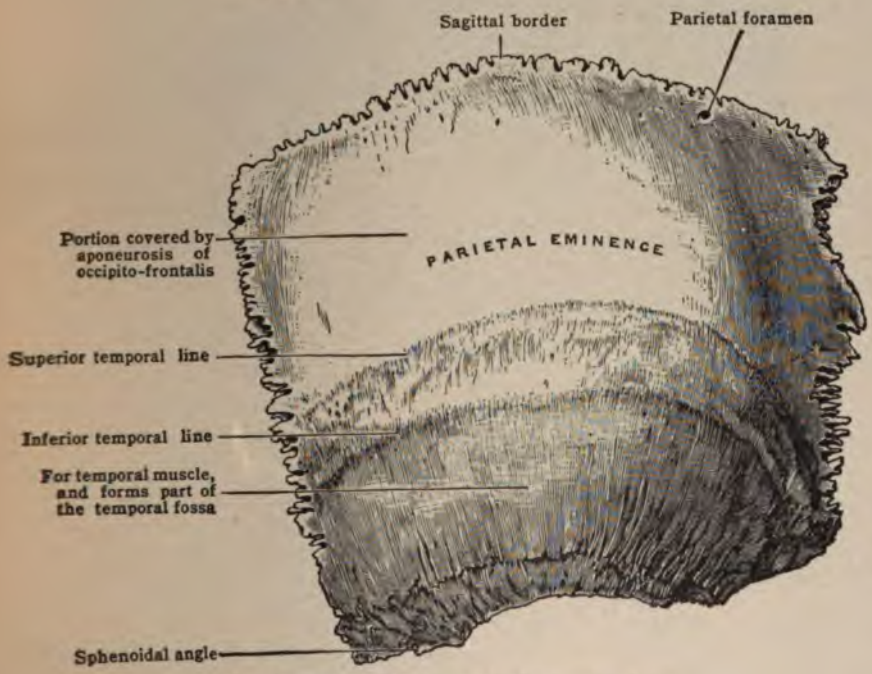


FIG. 70.—The Left Parietal (Outer Surface)

Angles

Superior anterior angle forms anterior fontanelle

Anterior inferior, received between frontal and great wing of sphenoid

Posterior inferior, articulates with mastoid of temporal

Posterior superior angle helps to form the posterior fontanelle

Articulation

Single

Occipital

Sphenoid
Frontal
Double
Temporal
Opposite parietal
Development
One center of ossification

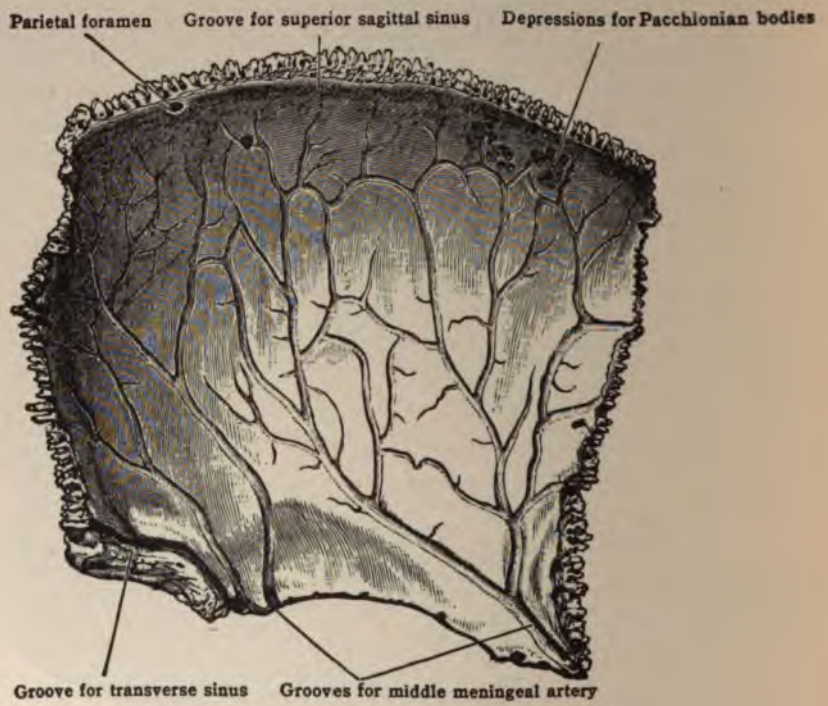

Parietal foramen
Groove for superior sagittal sinus
Depressions for Pacchionian bodies
Groove for transverse sinus
Grooves for middle meningeal artery

FIG. 71.—The Left Parietal (Inner Surface)

FACE BONES

Fourteen in number
Upper jaw
Single
Vomer 1
Pairs
Nasal 2
Maxilla (Superior maxillary) .. 2
Lacrimal 2
Zygoma (malar) 2

Palate 2
Inferior concha (turbinate).... 2

13

Lower jaw
Mandible (Inferior maxillary). 1

14

Vomer
Definition
Forms posterior and inferior part of nasal septum
Articulates
Superiorly with rostrum of sphenoid bone
For examination
Inferior border
Articulates with palate bone and palate process of maxilla (superior maxillary)
Anterior
Articulates with ethmoid
Posterior
Separates apertures of choanae (posterior nares)
Articulation
Sphenoid
Ethmoid
Maxilla (Superior maxillary)
Palate
Development
Single center

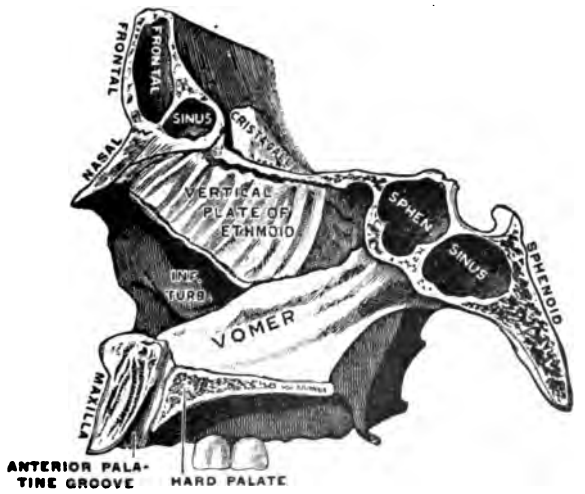


FIG. 72.—The Vomer Bone
Gerrish Anatomy (Lea & Febiger)

Os Nasale (Nasal Bones)
- Definition
  - Together form bridge of nose
- For examination
  - Outer surface
    - Convex from side to side, concave from above down
  - Inner surface
    - Curved
  - Superior border
    - Thick and articulates with frontal bone
  - Inferior border
    - Joined to lateral cartilages of nose
  - External border
    - Articulates with nasal process of superior maxillary bone
  - Internal border
    - Articulates with fellow
- Articulation
  - Cranium
    - Frontal
    - Ethmoid
  - Face
    - Nasal
    - Maxilla (superior maxillary)
- Development
  - One center of ossification

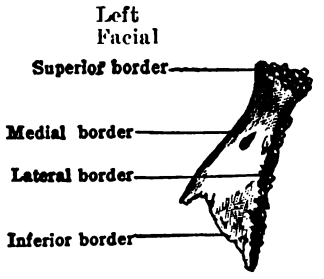


FIG. 73.—The Left Nasal Bone (Facial Surface)

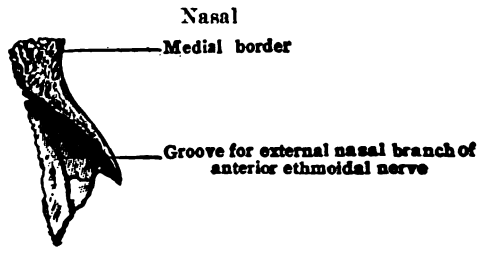


FIG. 74.—The Left Nasal Bone (Nasal Surface)

Morris Human Anatomy (Blakiston)

Maxilla (Superior Maxillary)
- Shows for examination
  - A—Body
    - This portion contains a hollow cavity called sinus maxillaris (antrum of Highmore)
      - Facies anterior (Outer surface) (Facial)

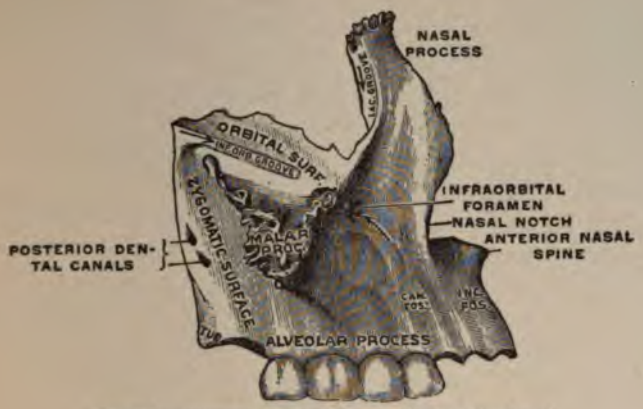


FIG. 75.—Superior Maxillary (Outer Surface)
Gerrish Anatomy (Lea & Febiger)

FIG. 75a.—Superior Maxillary (Inner Surface)
Gerrish Anatomy (Lea & Febiger)

Convex in shape and presents, from within out

a—Incisive fossae

b—Canine fossae, depressions below infra orbital foramen

c—Maxillary tuberosity for articulation with tuberosity of palate bones

Inner surface

Divided into two unequal parts by palatal process; portion below forms anterior roof of mouth, portion above the palatal process forms outer wall of nasal cavity. Shows

a—Inferior turbinated crest. Ridge of

bone, separating two wide and deep grooves corresponding to middle and inferior meatus of nose

b—The superior turbinated crest surmounts a groove that forms superior meatus of nose

c—Canalis nasolacrimalis (lachrymal groove) enters into formation of nasal duct by articulation with lacrimal and inferior concha (turbinated bone)

d—Aperture of maxillary sinus (antrum of Highmore)

Upper or orbital surface

This portion forms greater part of floor of orbit. Shows infra-orbital foramen and depression for inferior oblique muscle

Maxillary Sinus (Antrum of Highmore)

A cavity in the body of the superior maxillary bone; its walls correspond to the three surfaces of the body of the bone; contains infra-orbital, anterior and alveolar (posterior dental) canals. Its aperture communicates with middle meatus of nose; 1–2nd molar teeth project into antrum

B—Processus zygomaticus (Malar process)

Triangular process of bone for articulation with zygoma (malar bone)

C—Processus frontalis (nasal process)

Triangular process

Shows

1—Roughened portion for articulation with ethmoid

2—Superior turbinated crest which articulates with middle turbinated of ethmoid

3—Inferior turbinated crest, which separates middle of inferior meatus of nose

D—Alveolar process

Forms base of palate, shows curve of teeth

Shows

Alveoli or sockets for 16 teeth; in children, sockets for ten teeth

E—Palate process

Upper surface

Concave; forms portion of floor of nasal fossae; anteriorly shows foramen of Stenson, also two smaller foramina called Scarpa's which lead into anterior palatine canal

Under surface

Concave; forms anterior portion of roof of mouth. Shows a groove for anterior palatine nerves and vessels; posterior portion shows posterior palatine canal

Articulations

Single

Frontal
Ethmoid
Vomer

Double

Nasal
Opposite superior maxillary
Lacrimal
Malar
Palate
Inferior turbinate

Development

Four centers

a—Nasal and facial portion: one center
b—Orbital and malar portion: one center
c—Incisive portion: one center
d—Palate portion: one center

Os Lachrimal (Lachrimal)

Definition

Help to form inner wall of orbital cavity.

For examination

Outer surface

a—Groove for nasal duct
b—Smooth surface forms inner wall of orbit

Inner surface.

Forms part of middle meatus and articulates with ethmoid

Articulations

Frontal
Ethmoid
Superior maxillary
Inferior turbinate

Development

One center

FIG. 76.—Lacrymal Bone
Gerrish Anatomy (Lea & Febiger)

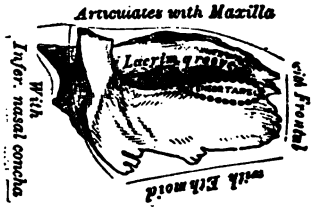


FIG. 76a.—Lacrymal Bone

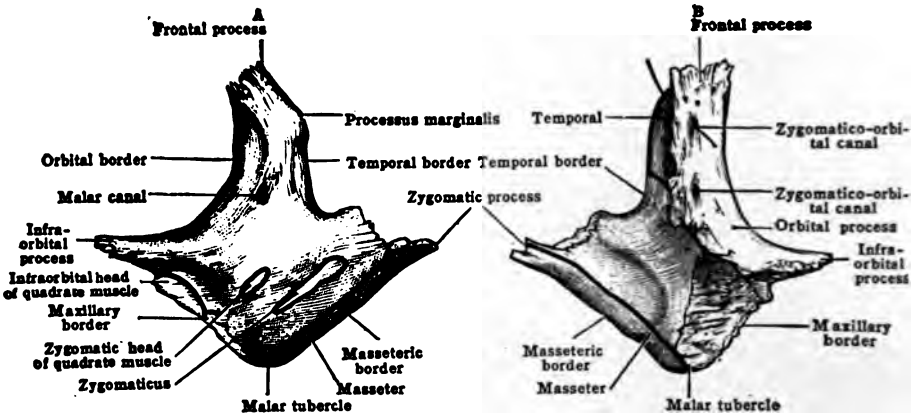


FIG. 77.—The Left Zygomatic Bone
A, the malar surface. B, the temporal and orbital surfaces.
Morris Human Anatomy (Blakiston)

Os Zygomaticum (Malar)

Definition

Two bones situated at the outer and upper portion of the face; they enter into formation of cavities of orbit, temporal fossa and zygomatic fossa

For examination

Outer surface

Convex and shows foramen zygomaticafacial (small malar foramen) for malar branch of temperomalar nerve

Inner surface

Articulates with superior maxillary bone

Processus frontosphenoidalis (frontal process)

Articulates with external angular process of frontal bone.

Orbital process

Forms outer wall and floor of orbit.

Processus temporalis (zygomatic process)

Articulates with zygomatic process of temporal bone

Articulations

Frontal

Sphenoid

Temporal

Superior maxillary

Development

Single center

Os Palatinum (Palate)

1—Pars horizontalis (horizontal plate)

Definition

Enters into formation of the roof of mouth and floor of nose

Surfaces

Superior surface

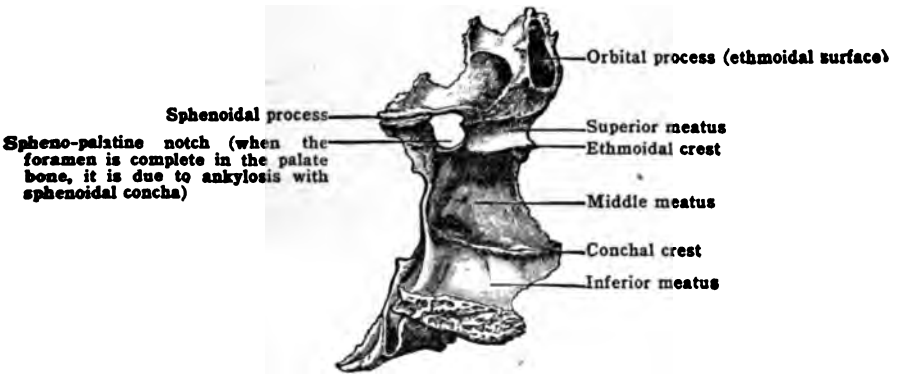

Orbital process (ethmoidal surface)
Sphenoidal process
Spheno-palatine notch (when the foramen is complete in the palate bone, it is due to ankylosis with sphenoidal concha)
Superior meatus
Ethmoidal crest
Middle meatus
Conchal crest
Inferior meatus

FIG. 78.—Palate Bone (Left) (Medial View)

Morris Human Anatomy (Blakiston)

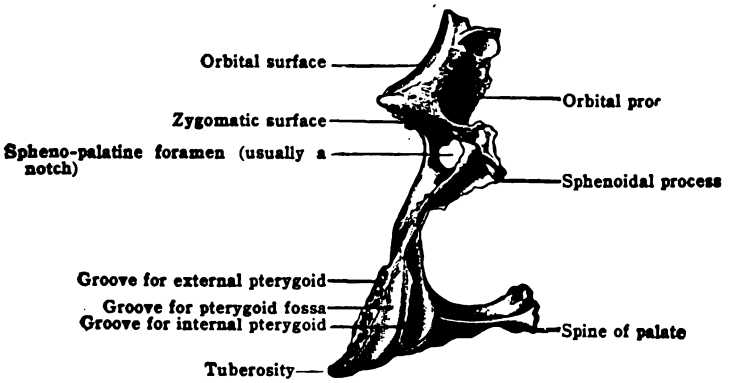


FIG. 79.—Palate Bone (Posterior View)

Morris Human Anatomy (Blakiston)

Smooth and concave and forms posterior portion of floor of nose

Inferior

Roughened and helps to form roof of mouth, shows

A—Deep groove which assists in forming posterior palatine canal

B—External and posterior small palatine foramina

Borders

Anterior border

Articulates with palate process of superior maxillary

Posterior

Free and gives attachment to soft palate

2—Pars perpendicularis (vertical plate)

Surfaces

Inner surface

Shows: crista ethmoidalis (superior turbinated crest); middle turbinated crest; and two grooves for superior and middle meatus of nose

Outer

Shows

A—Smooth surface for inner wall of sphenomaxillary fossa

B—Vertical groove, which helps to form posterior palatine canal

C—Rough surface with which superior maxillary bone articulates

D—Smooth surface which forms inner wall of antrum (Highmore)

Anterior border

Shows: maxillary process, which helps to close orifice of antrum

Posterior border

Articulates with pterygoid process of the sphenoid.

Upper border

Shows: a deep notch, which helps to form the sphenopalatine foramen

3—Pterygoid process

Fits in between two plates of pterygoid process of the sphenoid

Shows

Posterior surface

Enters into formation of pterygoid fossa

Lateral surface

For articulation with pterygoid plate of ethmoid and superior maxillary bone

Under surface

Forms roof of mouth and presents external and posterior small palatine foramen

4—Orbital Process

Definition

Projects upward and outward from anterior portion of the superior border of vertical plate of palate

Shows for examination

Superior orbital surface, which helps to form the floor of the orbit

External surface helps to form spheno-maxillary fossa

5—Sphenoidal process

This process of the palate curves upward, backward and inward

Shows

Upper surface

Articulates with the sphenoid and helps to form pterygo-palatine canal

Outer surface

Articulates with the pterygoid process of the sphenoid bone and helps to form inner wall of the sphenomaxillary fossa

Inner surface

Is concave and helps to form outer wall of the nasal fossa

Articulations

Sphenoid

Ethmoid

Vomer

Opposite palate

Maxilla (superior maxillary)

Inferior concha (turbinate)

Development

Single center

Inferior Concha (Turbinate)

Definition

Thin curved plate, which extends along outer wall of nasal fossa

Surface

Outer surface

Concave and forms part of inferior meatus of nose

Inferior surface

Convex and presents vascular grooves and canals

Borders

Upper border

Articulates with inferior turbinated crest of superior maxillary, shows for examination

1—Lacrimal process, which articulates with lacrimal and superior maxillary

2—Maxillary process over lower edge of antrum

3—Ethmoidal process, articulates with unciform process of ethmoid

Lower border

Is free and about ½ inch above the floor of the nose.

Articulations

Ethmoid

Superior maxillary

Lacrimal

Palate

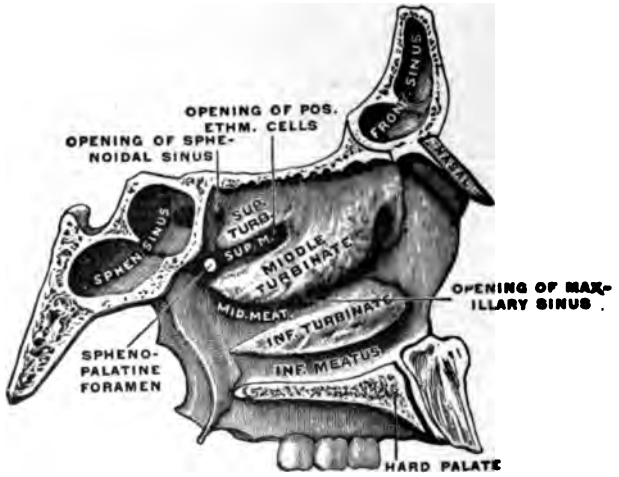


FIG. 80.—Concha Nasalis (Inferior Turbinated Bones) Inferior

Gerrish Anatomy (Lea & Febiger)

MANDIBLE (INFERIOR MAXILLARY) BONE

Definition

Shaped like horseshoe

Shows

A—Body

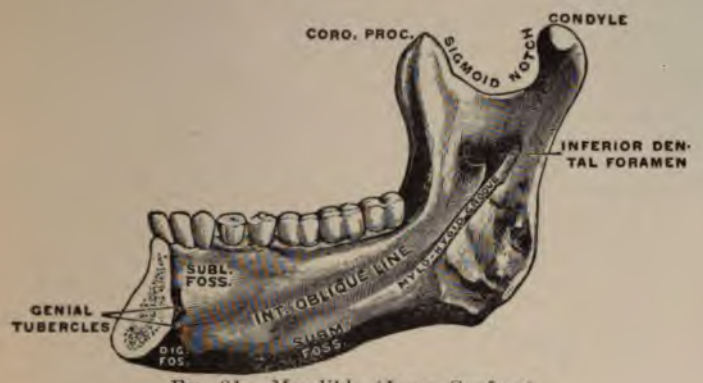


FIG. 81.—Mandible (Inner Surface)
Gerrish Anatomy (Lea & Febiger)

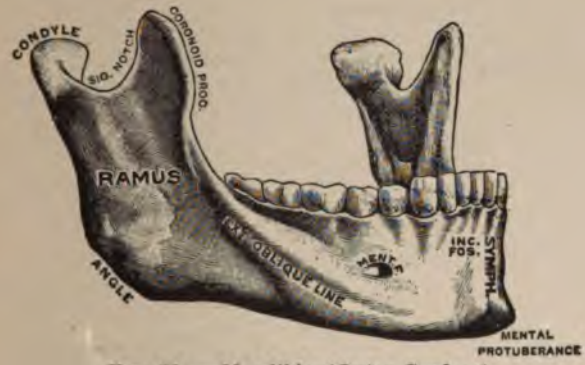


FIG. 81a.—Mandible (Outer Surface)
Gerrish Anatomy (Lea & Febiger)

External or cutaneous surface, convex from side to side, concave from above downward
Shows

1—Symphysis
Vertical ridge in median line

2—Protuberantia mentalis (mental process) from which is given off external oblique line of jaw which becomes continuous with anterior border of ramus

3—Incisive fossa, situated above oblique line of jaw

4—Mental foramen for mental vessels and nerves

Interior (or Buccal surface)
Concave from side to side, convex from above downward

1—Median depression

2—Spina mentalis (superior and inferior pairs of genial tubercles) on either side of median depression
3—Mylohyoid ridge for attachment of mylohyoid muscle
4—Sublingual fossa for sublingual gland
5—Submaxillary fossa for submaxillary gland

Superior border
Shows: sixteen alveoli for adult teeth; ten alveoli for child's teeth

B—Ramus

Internal surface
1—Canalis mandibulae (inferior dental canal)
2—Spine for attachment of internal lateral ligament
3—Mylohyoid groove

External surface
Oblique lines for attachment of masseter

Upper border
1—Coronoid process
Triangular in shape and gives attachment to temporal muscle
2—Condyloid process
A—Condyle for articulation with glenoid fossa of temporal
B—Neck, in front hollowed out to form pterygoid fossae
3—Incisura mandibulae (sigmoid notch) semilunar space separating above two processes

Lower border
Thick and rounded and unites with ramus to form angle of jaw

Articulations
Temporal

Ossification
Two centers.

ARTICULATIONS AND MUSCLES OF BONES OF CRANIUM

NAME	ARTICULATIONS	MUSCLES
Occipital	6	12
Sphenoid	12	12
Ethmoid	13	..

NAME	ARTICULATIONS	MUSCLES
Frontal	12	3
Temporal	5	14
Parietal	5	1

Sutures of skull

May be obtained by counting the number of cranial bones with which each cranial bone articulates.

Occipital	5
Sphenoid	7
Ethmoid	2
Frontal	4
Temporal	6
Parietal	10
	34 articulations

Now as it requires two bones to form a suture, by dividing total number by two, we get (17).

Sutures of vertex	5
Sutures of side	4
Sutures of base	8
	17

Sutures of Cranium

In the mesial line of the skull

Interparietal sagittal	1
Occipitosphenoidal or basilar	1
Spheno-ethmoidal	1
Sphenofrontal	1
Ethmofrontal	1
	5

At the vertex of the skull

Fronto-parietal or coronal (One on either side)	2
Occipito-parietal or lambdoidal (One on either side)	2
	4

At the sides of the skull

Sphenoparietal, one on either side	2
Temperoparietal, one on either side	2
	4

At the base of skull

Occipitotemporal, one on either side (occipitopetrosal, occipitomastoidal) 2

Sphenotemporal, one on either side (sphenopetrosal, sphenosquamosal) .. 2

4

Differences in form of skull

Skull shows variations in form, dependent on age and national characteristics

A—Early age

Posterior portion in excess of anterior portion; as age continues, frontal augmented. During first year of life, upper portion develops more rapidly than base. Proportion of face increases from 1/8 of entire bulk to 1/2 in adult life.

B—Female

Smoother, lighter and smaller, muscular markings less, frontal sinuses smaller, jaws narrower, frontal and occipital portions less capacious.

C—Race

Hindoo and Peruvian: small skull

Scandinavian: largest skull

Lower tribes

Prominence of temporal ridge, great width of zygomatic arches and anterior walls, projection of incisive teeth

Anterior region of skull

Face

Bounded above by nasal eminences and upper margins of orbit, below by prominence of chin, on either side by ramus of jaw and zygomatic (malar) bones. In mesial line, suture for two nasal bones above; below, suture for two maxillary bones, and symphysis of mandible. Face oval in form; shows four cavities, orbital and nasal

Bony orbit

Two in number on either side of nasal fossae; shape, quadrilateral pyramid

Composed

Single

Frontal

Ethmoid

Sphenoid

Pairs
Maxilla (superior maxillary)
Lacrimal
Zygoma (malar)
Palate

Communications
a—With cranial cavity by optic foramen and sphenoidal fissure
b—With fossae
1—Nasal
2—Temporal
3—Zygomatic
4—Sphenomaxillary (by sphenoidal fissure and nasal duct)
c—Nasal canal (by nasal duct)

Formation
Roof
Formed by orbital plate of frontal and lesser wing of sphenoid.
Shows for examination
A—Lacrimal fossa
B—Depression for pulley of superior oblique

Floor
Orbital surface of maxilla (superior maxillary)
Orbital process of zygoma (malar)
Orbital process of palate
Shows for examination
A—Infra-orbital groove and canal
B—Depression for inferior oblique muscle

Inner wall is formed by
Nasal process of maxilla (superior maxillary)
Lacrimal
Os planum of ethmoid
Body of sphenoid
Shows for examination
A—Groove for lacrimal sac
B—Crest of lacrimal bone

Outer wall is formed by
Orbital plate of zygoma (malar)
Orbital surface, great wing of sphenoid
Shows for examination
A—Orifice of zygomatic (malar) canal
B—Small spine for lateral (external) rectus

Angles, show for examination
- Superior external angle
  - *1*—Articulation of frontal and zygoma bones
  - *2*—Articulation of frontal and great wing of sphenoid
  - *3*—Sphenoidal fissure (foramen lacerum anterius)
- Superior internal angle
  - *1*—Suture between frontal, lacrimal and ethmoid
  - *2*—Anterior ethmoidal foramen
  - *3*—Posterior ethmoidal foramen
- Inferior external angle, shows
  - *1*—Sphenomaxillary fissure
- Inferior internal angle, shows
  - *1*—Suture by articulation of maxilla, palate, lacrimal and ethmoid
- Circumference, shows
  - *1*—Superior orbital notch
- Apex, shows
  - Optic foramen, formed by 2 roots of lesser wing of sphenoid

Muscles of orbit
- a—Superior rectus
- b—Inferior rectus
- c—Lateral rectus (external)
- d—Medial rectus (internal)
- e—Superior oblique
- f—Inferior oblique
- g—Levator palpebrae
- h—Tensor tarsi

Foramina opening into orbit
- Cranium
  - *1*—Optic
  - *2*—Sphenoidal fissure
  - *3*—Anterior ethmoidal
  - *4*—Posterior ethmoidal
- Face
  - *1*—Supra-orbital
  - *2*—Infra-orbital
  - *3*—Zygoma foramen
- Nose
  - *1*—Nasal duct
  - *2*—Zygomatic fossa
  - *3*—Sphenomaxillary fissure

Nasal fossae

Cavity of nose divided into two fossae by vertical septum

Bones entering formation

Single

Ethmoid
Sphenoid
Frontal
Vomer

Double

Nasal
Maxilla
Lacrimal
Palate
Inferior concha

Formation

Roof

Narrow, forms an arch; long axis lies in an anterior-posterior direction

Shows

A—Anterior portion; formed by nasal bones and nasal spine of frontal
B—Horizontal portion; formed by the under surface of cribriform plate of ethmoid
C—Posterior portion; formed by body of sphenoid
D—Opening into sphenoidal sinus
E—Olfactory foramina and nasal slit

Floor

Concave, formed by palatal process of maxilla and palate. Shows for examination

A—Suture between two bones
B—Anterior palatine canal
C—Anterior nasal spine of maxilla
D—Posterior nasal spine of palate bone
E—Crest which articulates with vomer

Inner wall

Vertical septum which separates nose into two fossae, formation

Principally

A—Perpendicular plate of ethmoid
B—Vomer

Smaller extent

A—Rostrum of sphenoid

B—Nasal spine of frontal
C—Crest of nasal
D—Crest of palate
E—Crest of maxilla

In front, triangular deficiency filled in by cartilage of septum

Shows

Nasopalatine groove and vascular and nervous furrow

Outer wall

Anterior portion; formed by

Middle turbinated process of ethmoid, internal surface of maxilla, inferior concha bone.

Central portion; formed by

Lacrimal bone, nasal process of maxilla

Posterior portion; formed by

Vertical plate of palate, internal pterygoid plate of sphenoid

Walls of nasal fossa

Shows from above downward

A—Superior concha of ethmoid
B—Superior meatus, into which opens
a—Sphenoidal sinus
b—Sphenopalatine foramen
c—Posterior ethmoid cells
C—Middle concha bone of ethmoid
D—Middle meatus, into which opens
a—Maxillary sinus or antrum
b—Anterior ethmoid cells
c—Frontal sinus through infundibulum
E—Inferior concha bones
F—Inferior meatus into which open
a—Nasal duct
b—Nasopalatine canal

Lateral region of Skull

1—Bony parts

A—Zygomatic arch
B—External auditory meatus
C—Mastoid process

2—Fossae

Temporal

Formed by following bones

1—Frontal
2—Great wing of sphenoid
3—Temporal
4—Anterior inferior angle of parietal
5—Zygoma

Boundaries
Above
Temporal ridge
Below
Zygomatic arch
Pterygoid ridge on great wing of sphenoid
Front
Zygoma
Frontal
Great wing of sphenoid
Behind
Temporal ridge

Sutures
a—Spheno-zygomatic
b—Spheno-frontal
c—Spheno-parietal
d—Squamo-sphenoidal
e—Fronto-parietal
f—Squamo-parietal

3—Zygomatic fossa
Boundaries
In front
Tuberosity of the maxilla bone
Internally
External pterygoid plate of the sphenoid bone
Above
Squamous portion of the temporal bone
Externally
Zygomatic arch
Ramus of lower jaw
Below
Alveolar border of the mandible bone

Communicates
Beneath the zygomatic arch with the temporal bone
Through the sphenomaxillary fissure with the orbital fossa
Through the sphenomaxillary fissure with the orbital sphenomaxillary fossa

4—Pterygopalatine (Sphenomaxillary fossa)

Definition
Narrow, elongated cavity, between pterygoid process of sphenoid and tuberosity of maxilla
Boundaries
Above
Under surface of the body of the sphenoid bone
Maxilla
Behind
Pterygoid process of the sphenoid bone
Internally
Vertical plate of the palate bone
Fossa has three fissures
a—Sphenoidal
b—Sphenomaxillary
c—Pterygoid maxillary
Foramina opening into it
On the posterior wall
Foramen rotundum
Vidian canal
Pterygopalatine canal
On the inner wall
Sphenopalatine foramen
At the lower portion
Superior orifice of the posterior palatine canal

Under Surface of Skull
Boundaries
In front
Alveolar arch and the teeth of the upper jaw
Laterally
Lower border of zygomatic bone
Zygomatic arch
Imaginary line from the zygoma to the mastoid process
Behind
Superior nuchal (curved) line of the occipital bone
Regions
From before backward
a—Roof of mouth
b—Posterior aperture of nasal cavity
c—Under surface of basilar process
d—Quadrilateral space on either side of basilar process
e—Under surface of occipital bone
Roof of mouth
Palatal process of maxilla and horizontal plate of palate. Shows

1—Anterior palatine canal
2—Incisive fossa (foramen of Stenson)
3—For nasopalatine nerve (foramen of Scarpa)
4—Pterygopalatine (posterior palatine canal)
5—Accessory palatine foramen
6—Transverse ridge

Posterior aperture of naris
a—Expanded alae of vomer
b—Pterygopalatine canal

Basilar process
Shows
1—Pharyngeal spine
2—Two rough depressions for muscles

Quadrilateral space
Formed by under surface of occipital, squamous and petrous portions of temporal and great wing of sphenoid on either side of basilar process. Shows
1—Foramen lacerum medium
2—Rough surface for muscles
3—Carotid canal
4—Vaginal process of temporal
5—Styloid process of temporal
6—Stylomastoid foramen
7—Foramen ovale
8—Foramen vesalii
9—Foramen spinosum
10—Auditory tube (eustachian tube opening)
11—Mandibular fossa (glenoid fossa)
12—Petrotympanico fissure (glaserian fissure)
13—Jugular fossa
14—Jugular foramen
15—Canalis hypoglossei (anterior condyloid)
16—Canalis condyloideus (posterior condyloid)
17—Foramen for tympanic branch of glossopharyngeal (Jacobson's nerve)
18—Foramen for auricular branch of vagus (Arnold's nerve)
19—Aqueductus cochlea

Under surface of occipital
a—Condyle of occipital
b—Jugular process of occipital
c—Canalis hypoglossei (anterior condyloid foramen)
d—Occipital crest

e—Supreme nuchal, superior nuchal (superior curved lines of occiput)

f—Inferior nuchal line (inferior curved line of occiput)

g—External occipital protuberance

Foramina on Base of Skull

In the anterior fossa

A—Ethmoidal fissure

Transmits the nasal nerve and the ethmoidal artery

B—Olfactory foramina

Filaments of the olfactory nerve and the nasal branches of the ethmoidal artery

C—Anterior ethmoidal canal (fronto-ethmoidal)

Anterior ethmoidal artery and the nasal nerve

D—Posterior ethmoidal canal (postero-ethmoidal)

Posterior ethmoidal artery and vein

E—Optic foramen

Optic nerve and opthalmic artery

In the middle fossa

A—Foramen lacerum obitale (sphenoidal fissure, sphenofrontal foramen) transmits

The third, the fourth, the three branches of the ophthalmic division of the fifth, the sixth cranial nerves and filaments of the sympathetic; the ophthalmic vein; a branch of the lacrimal artery; and sometimes the lacrimal artery and a process of the dura mater

B—Foramen rotundum

Maxillary nerve, or second branch of the trigeminal (trifacial) or fifth cranial nerve

C—Foramen Vesalii

A small vein, one of the emissary veins of the head (Santorini)

D—Foramen ovale

The two roots of the mandibular (inferior maxillary) nerve, or third branch of the fifth cranial nerve; the lesser petrosal nerve and the small meningeal artery; a branch of the internal maxillary

E—Foramen spinosum

Middle meningeal artery, the two meningeal veins, and filaments of the sympathetic from the cavernous plexus

F—Foramen lacerum (sphenopetrosal foramen) transmits the

Internal carotid artery; the carotid plexus; the large

petrosal nerve; and a meningeal branch from the ascending pharyngeal artery

G—Small foramen for

Lesser petrosal nerve

H—Hiatus fallopii

Large petrosal nerve; a branch of the middle meningeal artery, which anastomoses with the stylomastoid artery; a branch of the posterior auricular.

In the posterior fossa

A—Meatus auditorius internus

Facial and auditory nerves and the auditory artery (a branch of the basilar)

B—Aqueduct of the Vestibule

A small artery and vein, and a process of the dura

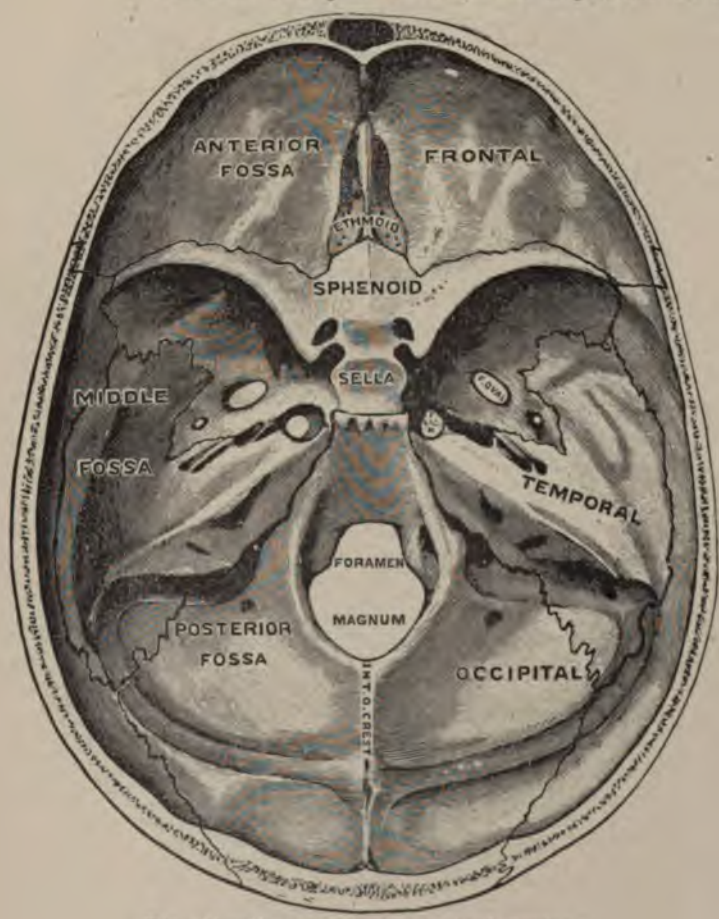


FIG. 82.—Base of Skull, Cerebral Surface

Gerrish Anatomy (Lea & Febiger)

mater

c—Foramen lacerum posterius (occipitopetrosal, jugular) transmits

Glosso-pharyngeal, pneumogastric and spinal accessory nerves; the internal jugular vein, and meningeal branches from the ascending pharyngeal and occipital arteries

D—Mastoid

A small vein which establishes a communication between the occipital vein and lateral sinus and occasionally a small arterial twig from the occipital called mastoid artery, which ramifies in the dura mater

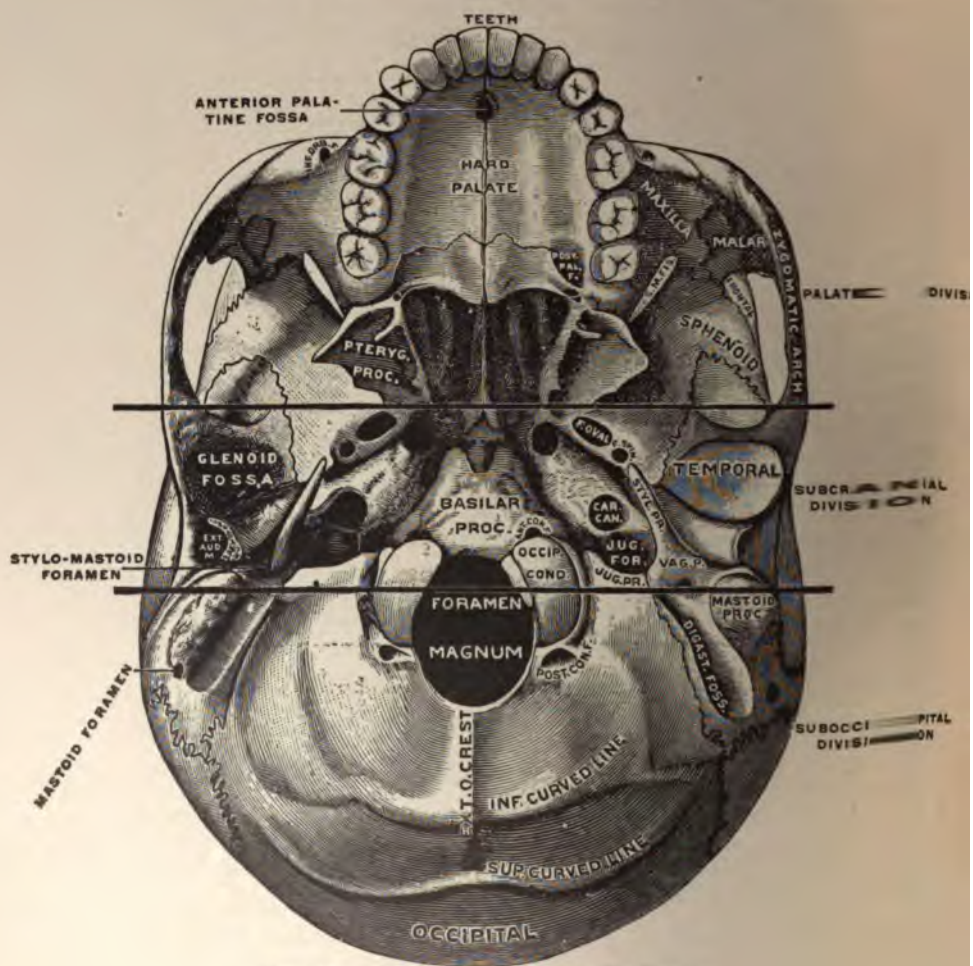


Fig. 83.—Base of Skull, External Surface

Gerrish Anatomy (Lea & Febiger)

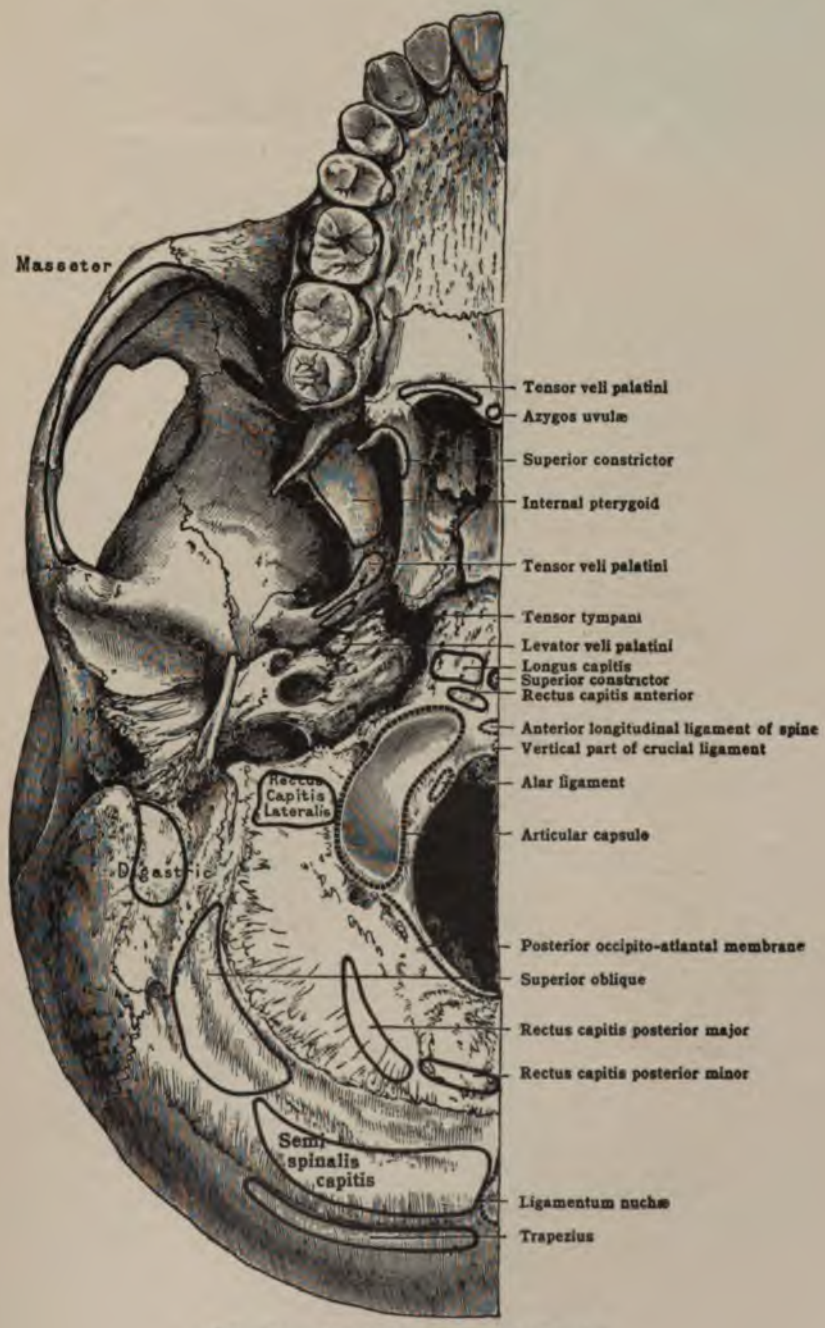


FIG. 84.—The Skull (Norma basilaris)
Morris Human Anatomy (Blakiston)

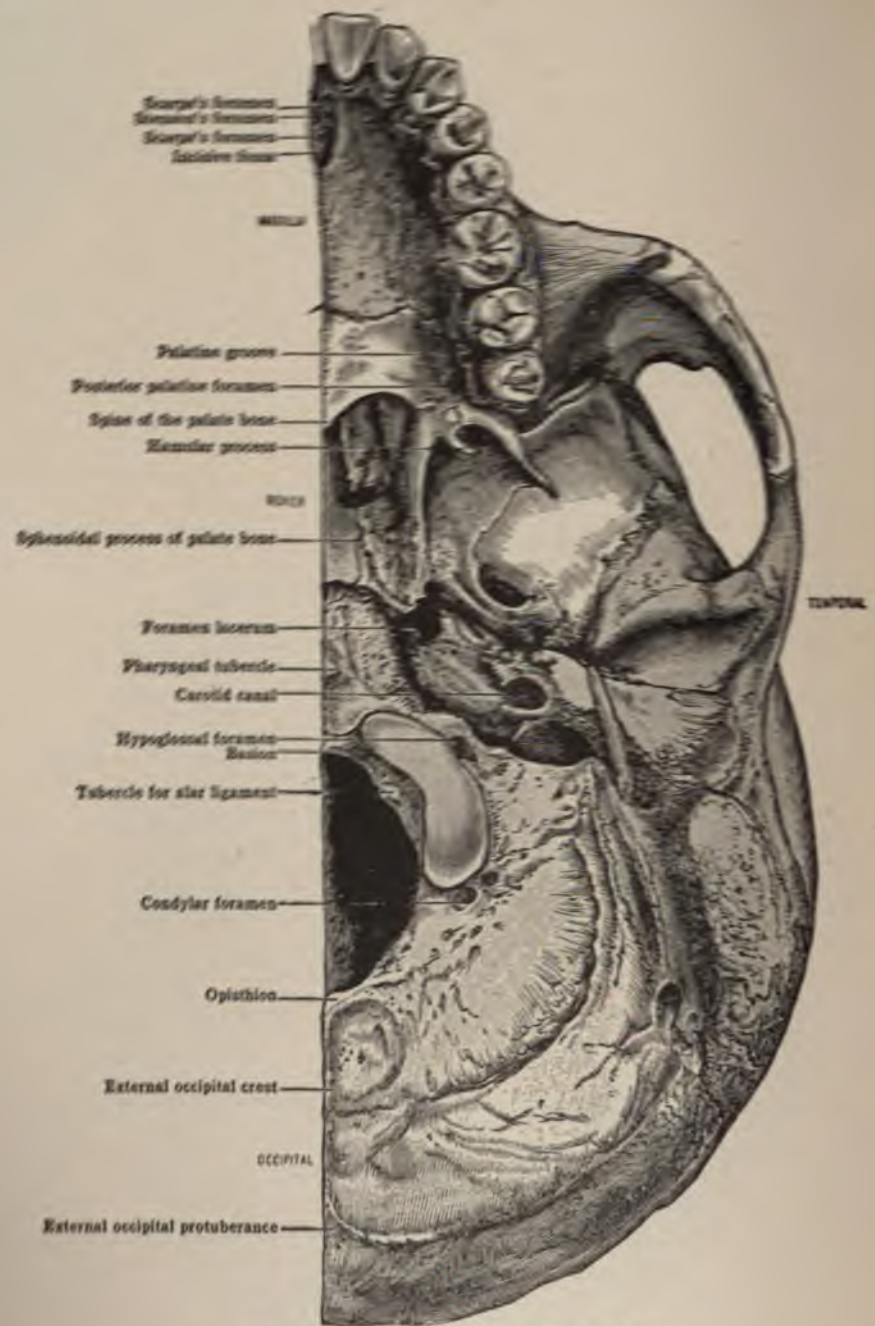


FIG. 85.—The Skull (Norma basilaris)
Morris Human Anatomy (Blakiston)

E—Anterior condyloid
The hypoglossal nerve and a meningeal branch from the ascending pharyngeal artery
F—Posterior condyloid
Posterior condyloid vein, establishing a communication with the vertebral vein and lateral sinus
Single or Mesial
A—Anterior fossa
Foramen cæcum
Transmits a small vein from the lining membrane of the nose to the superior sagittal (longitudinal) sinus and lodges also a fold of the dura mater
B—Posterior fossa
Foramen magnum
Medulla oblongata and its envelopes, the vertebral arteries and the spinal accessory nerves

SKELETON OF TRUNK

Consists of
1—Vertebral column
2—Thorax
3—Bony pelvis
Vertebral column
Function
A—Column to support weight of head and trunk
B—Canal to lodge spinal cord
C—By intervertebral canals affords communication between spinal cord and various organs of body through spinal nerves
D—System of levers, upon which muscles of trunk may act
E—Flexible and elastic, by means of cartilages and ligaments
General characteristics of vertebra
1—Body
Anterior surface
Convex from side to side
Slightly concave from above downward
Has small foramina upon it for the transmission of blood-vessels
Posterior surface
Concave from side to side
Flat from above downwards
Has one or more apertures for the venæ basivertebralis

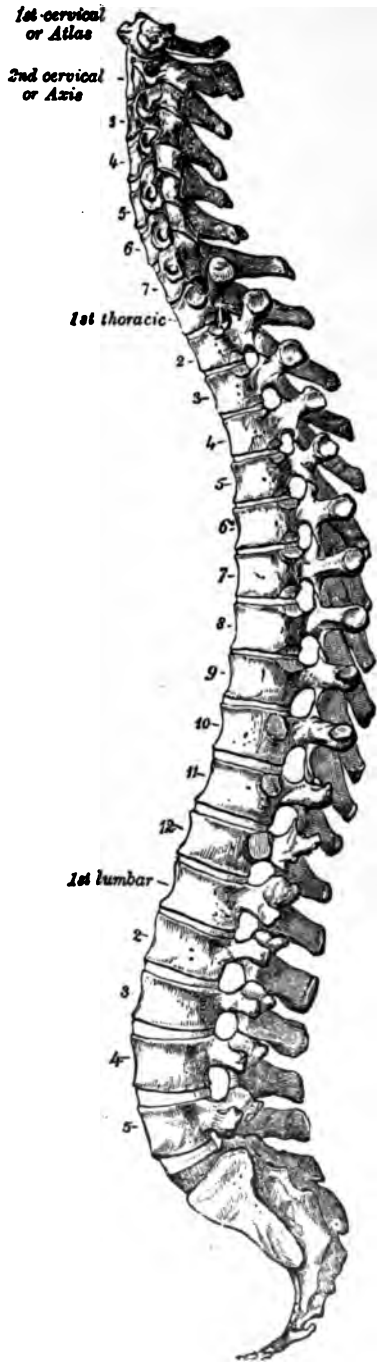


FIG. 86.—Cervical Vertebrae

Upper surface
Concave
Roughened for the intervertebral fibrocartilage
Broadened at its circumference by a prominent rim of bone
Under surface
Concave
Roughened for the intervertebral fibrocartilage
Broadened at its circumference by a prominent rim of bone

2—Spinal foramen
Pentagonal arch, bounded by posterior surface of body, pedicles and laminae

3—Spinous process
Projects backward from point of junction of 2 laminae

4—Transverse process
Two in number, one each side; projects outward from sides of arch

5—Articular processes
Four in number, two superior and two inferior, situated at junction of pedicle and laminae

6—Radix arcus vertebrae (Pedicles)
Project backward hollowed out to form notches which in turn form intervertebral foramina for escape of spinal nerves and vessels

7—Laminae
Broad and flattened plates complete the arch and help to form spinal foramen

CONTRAST OF CERVICAL, DORSAL AND LUMBAR VERTEBRAE

Body

Cervical

Small in size, upper surface concave, under surface convex, anterior border rounded

Dorsal

Intermediate in size, heart shaped, thickest behind; has two demi-facets on each of its sides

Lumbar

Larger than cervical or dorsal, very broad, thickest in front.

Raldix arcus vertebrae (Pedicles)

Cervical

Arise from lower part of body

Dorsal

From upper part of body

Lumbar

From upper part of body

Notches

Cervical

Superior the deepest

Dorsal

Inferior the deepest

Lumbar

Inferior the deepest

Laminae

Cervical

Long and narrow

Dorsal

Short and broad

Lumbar

Short, broad and thick

Spinal opening

Cervical

Large and triangular

Dorsal

Small and round

Lumbar

Triangular and intermediate in size

Spinous process

Cervical

Directed horizontally backward, short and bifid, groove inferiorly

Dorsal

Directed obliquely, long and triangular, ends in a single tubercle

Lumbar

Directed backwards, thick and quadrilateral; rough vertical border

Transverse process

Cervical

Grooved superiorly; vertebral foramen at base, on the outer side of the pedicle, and in front of the articular process.

Dorsal

Long, thick and oblique; extremity enlarged; facet on anterior surface

Lumbar

Long, slender horizontal accessory tubercle present behind the pedicle and in front of the articular process

Articular process

Cervical

Superior look backward and upward, inferior look downward and forward. Form two small vertical columns

Dorsal

Superior look backward and outward; inferior look forward and inward. Form two columns which are vertical

Lumbar

Superior look backward and inward; inferior look forward and outward. Superior are concave and widely separated, inferior are convex and nearer together than the superior

Characteristics peculiar to certain vertebrae

Cervical

A—Atlas (1st cervical)

The anterior arch presents

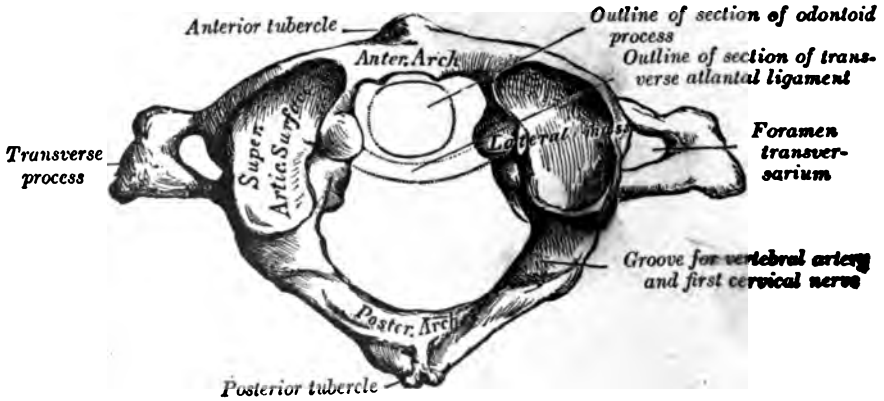


FIG. 87.—First Cervical Vertebra

1—Anterior surface
Convex in shape, a tubercle in its center, for the attachment of ligaments and the longus colli muscle
2—Posterior surface
Concave in shape, an oval facet in its center, for the articulation of the dens (odontoid process) of the episthropheus (axis)
3—Upper and lower border
To which are attached the ligaments
The posterior arch presents
1—Grooves for the
Superior intervertebral artery
Inferior intervertebral artery
2—A tubercle for the rectus capitis posticus minor
The lateral masses present
1—Four tubercles
Two superior
Two inferior for transverse ligament
2—Two transverse processes, which are large and are perforated by a large foramen (vertebral)
3—Two superior articulate surfaces which are
Large, oval, concave; looking upwards, inwards and backwards
4—Two inferior articular surfaces
Smaller, flat and circular; looking downwards and inwards
Articular surfaces
1—The superior set rest upon the body, pedicle and transverse process
They are large, flat and circular; look upwards and downwards
2—The inferior set are smaller in size and look downwards and forwards

B—Epistropheus (Axis, 2nd cervical)
Body
Thicker in front than from behind, triangular in shape
Dens (Odontoid process)
This process presents
A—Apex
Gives attachment to the ligament Apicis dentis (occipito-odontoid) and laterally to the alar (check) ligaments

B—Body

Articulates with the atlas in fr
hind, it lies in relation with th
verse ligament

C—Neck

Constricted into a channel for th
verse ligament

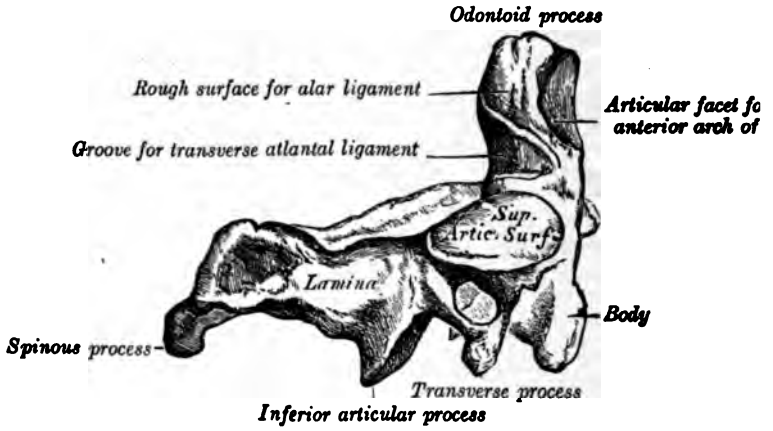


FIG. 88.—Second Cervical Vertebra

D—Vertebra Prominens (7th cervical)

Spinous process long, thick, prominent; ends i

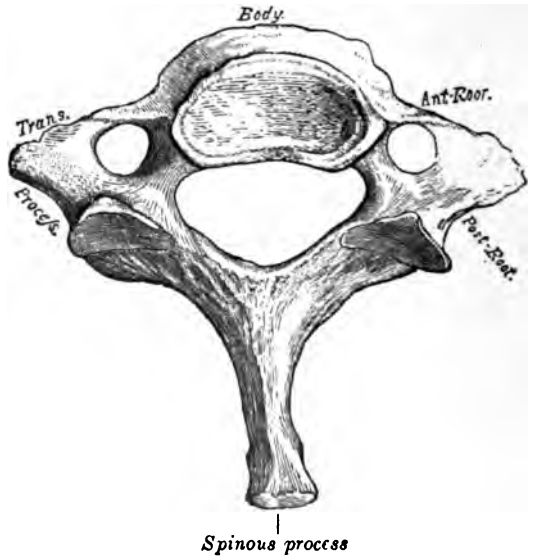


FIG. 89.—Seventh Cervical Vertebra

gle tubercle for ligamentum nuchae; transverse process large, its foramen small or absent

Dorsal

A—1st Dorsal

a—Complete facet above

b—Demi-facet below

c—Articular process oblique

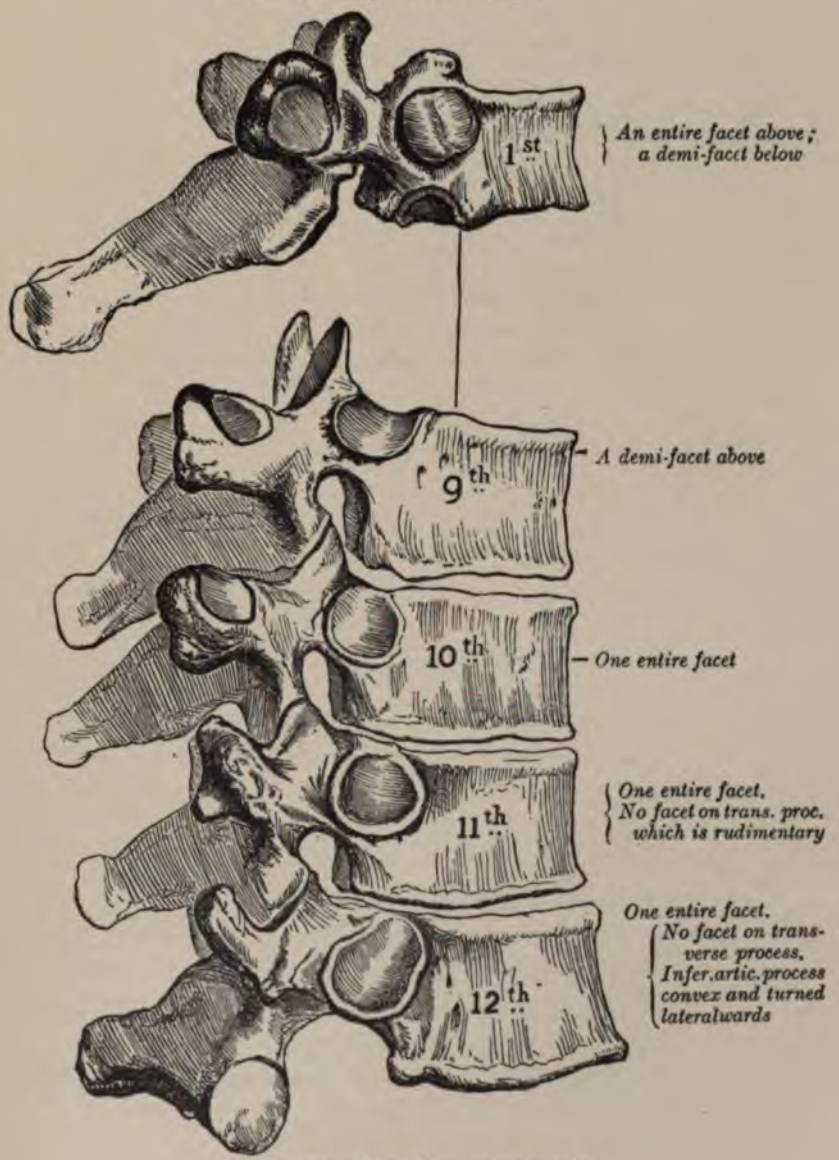

1st
An entire facet above; a demi-facet below
9th
A demi-facet above
10th
One entire facet
11th
One entire facet. No facet on trans. proc. which is rudimentary
12th
One entire facet. No facet on transverse process. Infer. artic. process convex and turned lateralwards

FIG. 90.—First Thoracic Vertebra

B—9th Dorsal
a—One demi-facet on upper part of body
C—10th Dorsal
a—One facet on upper portion of body
b—One facet on transverse process
D—11th Dorsal
a—One facet
b—Transverse process short, no articular facet for rib
E—12th Dorsal
a—Complete facet for rib
b—No facet on transverse process
c—Inferior articular processes are convex, look forward and outward

Lumbar
A—5th Lumbar
a—Body thicker in front than behind
b—Spinous process small
c—Inferior articular processes more apart than superior
d—Transverse process longer than other lumbars; thicker and inclined upward

Structure of vertebrae
Light, spongy, cancellous tissue with a thin coating of compact tissue on outside perforated by orifices for passage of vessels

Development
Consist of 3 primary cartilaginous portions, one for each lamina and one for the body. After 16 years, three secondary centers: one for spinous process and two for transverse processes. After the 21st year there are two new centers for the body

Vertebral column as a whole
Anteriorly, resembles two pyramids, united at bases: at junction of 5th lumbar and sacrum

Upper pyramids composed of 3 smaller pyramids
A—First, apex upward, composed of 6 lower cervical
B—Second, composed of first 4 Dorsal, which diminish in size
C—Third, from 4th Dorsal to sacrum; increases in size
Laterally
Presents certain curves
The cervical curve (convex anteriorly)

Origin
From the apex of the Dens (odontoid) process of the epistropheus (axis)
Termination
At the middle of 2nd dorsal vertebra
The Dorsal curve (concave anteriorly)
Origin
From the middle of the 2nd dorsal vertebra
Termination
At the middle of the 12th dorsal
The lumbar curve (convex anteriorly)
Origin
From the middle of the 12th dorsal vertebra
Termination
At the sacro-vertebral angle
The pelvic curve (concave anteriorly)
Origin
From the sacro-vertebral angle
Termination
At the tip of the coccyx

Length

Above the sacrum the spinal column corresponds to 1/3 length of individual

Centers of ossification

Three primary centers of ossification are

Body	1
Laminae	2
	3

Five complementary centers are

Upper surface	1
Lower surface	1
Transverse process	2
Spinous process	1
	5

Important relations of special vertebrae

Third cervical vertebra corresponds to
a—Superior opening of the larynx
b—Bifurcation of the common carotid artery
c—Point of origin of the external and internal carotid arteries

d—Upper cervical ganglion of the sympathetic system of nerves

Fifth cervical vertebra corresponds to

a—Lower end of the larynx
b—Upper end of the trachea
c—Lower end of the pharynx
d—Origin of the esophagus
e—The middle cervical ganglion of the sympathetic system of nerves

Second lumbar vertebra corresponds to

a—Termination of the duodenum
b—Commencement of the jejunum
c—Lower border of the pancreas
d—Upper root of the mesentery
e—Origin of the superior mesenteric artery
f—Commencement of the thoracic duct
g—Opening of the ductus communis choledochus
h—Commencement of the vena porta
i—Commencement of the cauda equina
j—Termination of the spinal cord
k—Crura of the diaphragm

RIBS

Definition

12 in number on each side, osseous arches extending from vertebral column to sternum; posterior 4/5 bone, anterior 1/5 cartilage

A—Increase in size from 1st to 7th, then diminish in size
B—Breadth of ribs and width of intercostal spaces increase from above down
C—Obliquity increases from 1st to 9th and decreases from 9th to 12th
D—Ribs are both curved and twisted upon themselves
E—Angle; is farther from head from above down
F—Most vascular bones in body
G—Vessels run near lower border

Classification

1—True; these are the upper 7, which articulate with the sternum by their own cartilages
2—False; three have a common cartilage which does not reach the sternum
3—Floating; two in number, movable at their anterior extremities

Description
- Posterior extremity
  - Head
    - a—Two oblique facets for articulation with bodies of 2 adjoining vertebrae
    - b—Horizontal ridge for interarticular ligament
  - Neck
    - a—One inch in length, flattened from before backward
    - b—Anterior surface smooth
    - c—Posterior surface roughened
    - d—Upper border forms a crest for the superior costotransverse ligament
    - e—Lower border, rounded and smooth
  - Tuberosity
    - a—Most developed on upper ribs
    - b—Articular portion shows facet for vertebra
    - c—Nonarticular portion roughened for attachment of costotransverse ligament
  - Shaft
    - External surface
      - Convex
        - A—Posterior angle consists of a roughened line extending downward
        - B—Anterior angle similar to posterior
        - C—Rounded portion, between tubercle and angle of rib
    - Internal surface
      - Concave
        - A—Ridge for intercostal muscle
        - B—Groove for intercostal vessels and nerves
    - Upper border
      - *I*—Smooth; gives attachments to intercostal muscles
    - Lower border
      - Thin and sharp
- Anterior extremity
  - Compressed and flattened from before backward; a deep oval depression for cartilage

Peculiar ribs
- First rib
  - Upper surface
    - a—A rough impression for the scalenus medius muscle
    - b—A tubercle for the scalenus anterior muscle
    - c—Two grooves, the anterior one being for the sub-

clavian vein and the posterior one for the subclavian artery

Under surface

No groove or ridge

Inner border

Tubercle for scalenus anticus

Head

Single facet, tuberosity and angle blended

Anterior extremity

Large and thick

Second Rib

Outer or upper surface

a—Rough spots near its middle for the 1st and 2nd serrations of the serratus anterior (magnus) muscle

b—A rough posterior impression for the scalenus posterior (posticus) muscle

Tenth Rib

Single articular facet

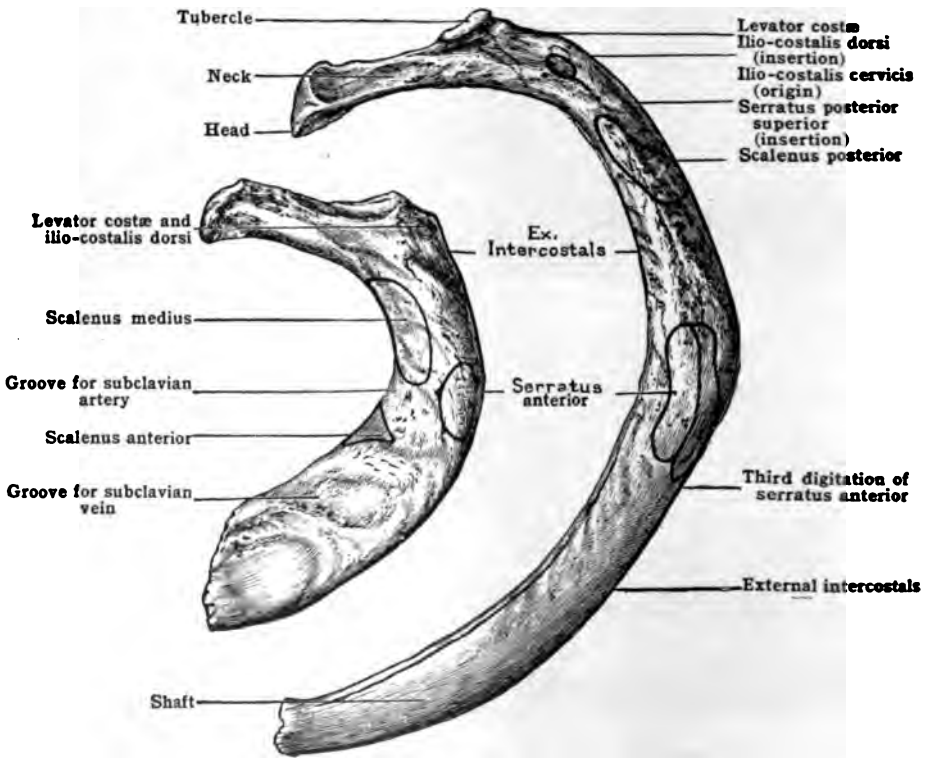


FIG. 91.—First and Second Ribs (Viewed from Above)

Morris Human Anatomy (Blakiston)

Sternum

Divisions

Manubrium

Thickened upper portion of bone; broad above, narrow below, articulates with clavicle and 1–2nd ribs

Corpus sterni (Gladiolus)

Central portion of bone; articulates with 3–4–5–6th

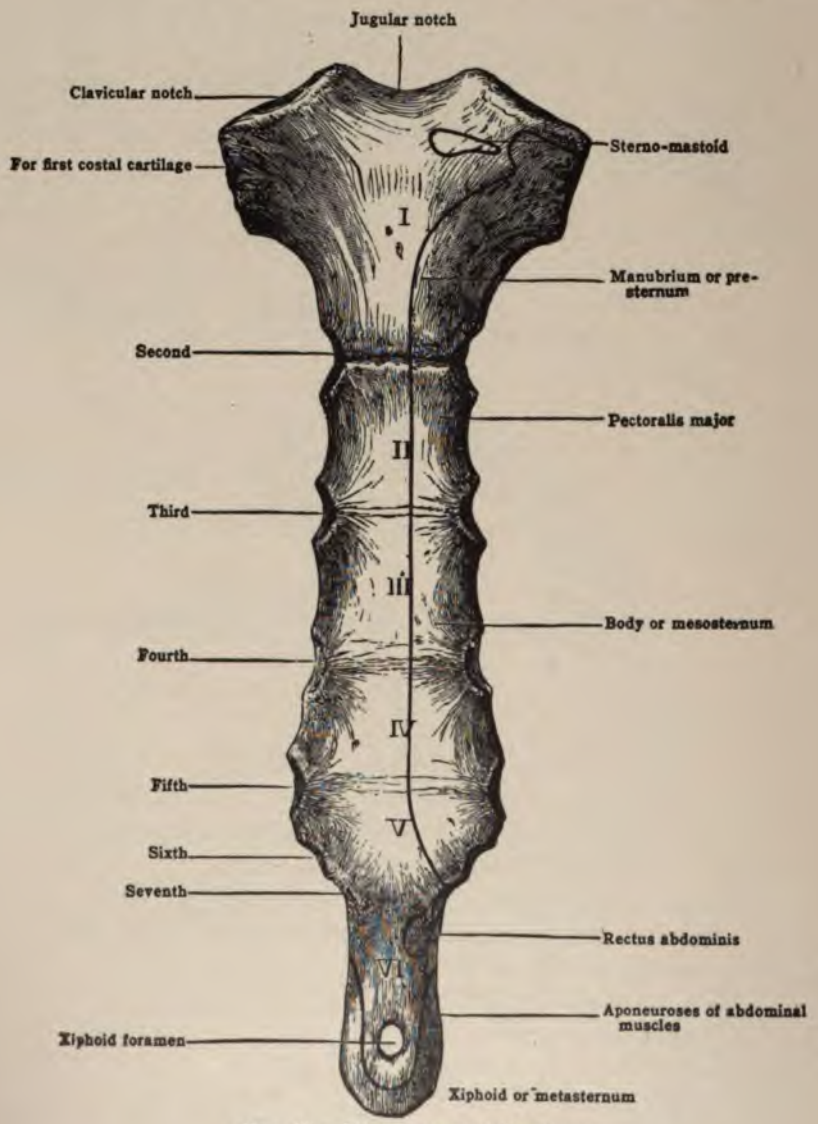


FIG. 93.—Illustration of Sternum

Morris Human Anatomy (Blakiston)

costal cartilages and in part with 2–7th. Sometimes perforated by central foramen

Ensiform (Xiphoid)

Terminal portion deflected: gives attachment to

1—Linea alba

2—Anterior abdominal aponeurosis

3—Inner fibers of rectus abdominis

Outer surface

Three segments

a—Manubrium; convex from side to side, concave from above down

b—Gladiolus; flat, traversed by 3 horizontal lines

c—Xiphoid appendix; curved

Posterior surface

Smoother; concave, marked by same three lines

Superior border

Thick and shows notch (interclavicular). On either side, shows clavicular facets

Lateral borders

Seven articular notches for ribs

Articulation; with

Clavicle, cartilages of seven true ribs, and common cartilages of three false

Development: centers of ossification

Manubrium	1
Corpus sterni (Gladiolus)	4
Xiphoid (Ensiform) appendix	1
	6

THORAX

Thorax in general

Conical, convex walls, axis downward and forward, broadest below and in its transverse measurement, bounded by dorsal vertebrae, ribs, costal cartilages and sternum

Upper opening

Narrow, heart-shaped, inclined downward and forward. Bounded behind by 1st dorsal vertebra; laterally by 1st rib; in front by manubrium; gives passage to

A—Trachea

B—Esophagus

C—Large vessels of the neck

D—Vagus (pneumogastric) nerve
E—Phrenic nerves
F—Sympathetic nerves
G—Apex of the lung during inspiration
H—Thoracic duct

Lower opening

Widest in transverse diameter; opposite xiphoid (ensiform) appendix; filled below by diaphragm; bounded behind by 12th dorsal; laterally by lower 2 ribs; in front by ensiform appendix

Outer surface

Depth in front, 8 inches; posterior portion 12 inches; lateral depth 12 inches; posterior aspect depressed, marked by prominence of the spine, and by two vertebral grooves

Cavity contains

1—Trachea, bronchial tubes and lungs
2—Heart and pericardium
3—Arch of the aorta
4—Thoracic aorta and its branches
5—Pulmonary artery
6—Internal mammary artery
7—Superior and inferior vena cavae
8—Pulmonary veins
9—Innominate veins
10—Azygos veins
11—Bronchial veins
12—Esophagus
13—Thoracic duct
14—Vagi (pneumogastric) nerves
15—Phrenic nerves
16—Splanchnic nerves
17—Lymphatic vessels and glands

1—Smaller capacity than male
2—Sternum shorter
3—Superior opening larger
4—Upper ribs more movable

Topographical

1—Nipple of male: space between 4–5th ribs, 3 to 4 inches external to cartilage
2—Scapula ends at space between 7th and 8th ribs
3—Line around chest, at level of nipple, intersects 6th rib in midaxillary line; seat of election in tapping chest

PELVIS

Composed of

1—Sacrum 1
2—Coccyx 1
3—Os Innominata 2

4

FIG. 94.—The Male Pelvis
Morris Human Anatomy (Blakiston)

Sacrum

Consists of 5 vertebrae blended into one. Shape quadrangular pyramid with a truncated apex. Sacrum forms with last lumbar a projection called promontory of sacrum

Anterior surface

Concave from above down and from side to side; traversed by 4 ridges; shows four sacral foramina, also 4 shallow grooves for pyriformis muscle. Shows 2 lateral masses due to blending of transverse process

Posterior surface

Narrow, convex, and uneven

Shows

1—Three or four tubercles which represent spinous processes of blended vertebrae

2—Longitudinal groove represents articular process

3—Series of indistinct tubercles; lower two blended to form sacral cornua, which articulate with coccyx

4—Four posterior sacral foramina for spinal nerves

5—Series of eminences called posterior transverse processes; between processes are sacral grooves

Lateral surface

Broad above and becomes narrower, upper surface called articular, covered with cartilage, serves for articulation with ilium; lower portion becomes thin and gives attachment to sacro-tuberous (sacrosciatic) ligament

Base

Appearance of lumbar vertebra

Apex

Small oval surface for articulation with the coccyx

Development: 35 centers

Bodies: three each (times 5 equals)	15
Arches: two each (times 5 equals)	10
Lateral masses: three each (times 2 equals)	6
Lateral surfaces: two each (times 2 equals)	4
	35

FIG. 95.—Sacrum (Posterior Surface)
Gerrish Anatomy (Lea & Febiger)

Articulations

5th lumbar	1
Coccyx	1
Os innominata	2
	4

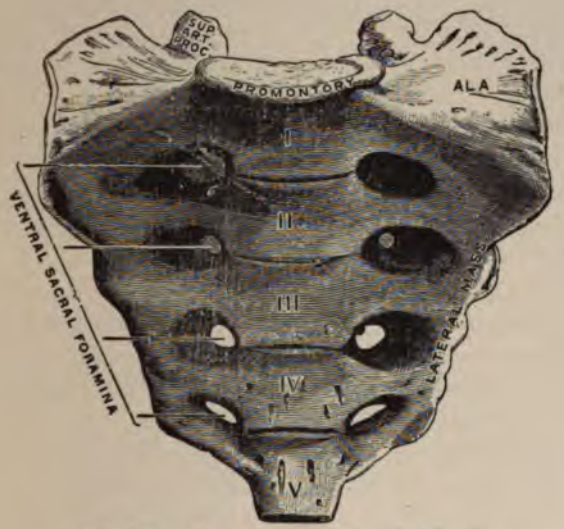


FIG. 95a.—Sacrum (Anterior Surface)
Gerrish Anatomy (Lea & Febiger)

COCCYX

Consists of 4 or 5 rudimentary vertebrae

First segment shows 2 cornua which articulate with sacrum and help to form foramina for 5th sacral nerve. Triangular in shape. Base to sacrum; apex rounded

Ossification

Four centers: one for each piece

FIG. 96.—Coccyx (Anterior Surface)

FIG. 96a.—Coccyx (Posterior Surface)

Articulation
Sacrum

OS INNOMINATA

OS COXAE

Composed of three portions
1—Ilium
2—Ischium
3—Pubis

Unite to form
1—Acetabular or cotyloid cavity
Affords an articular surface for head of femur, deep hemispherical and composed of 3 parts
a—Ilium 2/5
b—Ischium 2/5
c—Pubis 1/5
Direction: downward, forward, and outward
Ring deficient in front and below
Cotyloid notch, opening in margin of acetabulum leading into a central depressed portion
Margin of notch gives attachment to round and transverse ligaments; central depression lodges a mass of fat
2—Obturator foramen (thyroid)
Foramen between pubes and ischium; large and oval in male, small and triangular in female
Closed by membrane called obturator membrane

Ilium
Superior expanded portion of os innominata
Outer Surface
Convex in front, concave behind; shows for examination
1—Three curved lines
2—Three surfaces for muscular attachment
3—A section of the acetabulum
4—A groove for the reflected tendon of the rectus femoris
Inner Surface
a—Internal fossa, bordered below by ileopectineal line
b—Sacro-iliac surface, covered with cartilage and gives attachment to posterior sacro-iliac ligament
c—True pelvis that portion which forms a segment of the acetabulum
Upper border or crest
Convex from before backward; curved into segment

of circle, posterior portion concave from side to side. Divided into: an outer lip, an inner space called the middle lip, and the inner lip

Anterior border

Concave, vertical in direction; presents, from above downward

1—Anterior superior spinous process

2—Notch

3—Anterior inferior spinous process

4—Broad shallow groove

Posterior border

a—Posterior superior spinous process

b—Posterior inferior spinous process

c—Upper border of incisura ischiadica major (great sacrosciatic notch)

Ischium

Lowest, posterior, thickest portion

Shows for Examination

Ramus superior ossis ischii (Body)

External surface forms 4/5 of acetabulum

Shows a groove and helps form obturator foramen

Inferior surface

Lowest part of lateral boundary of true pelvis

Posterior surface

Quadrilateral and smooth

Inner border shows

1—Great sacrosciatic notch

2—Spine of ischium

3—Lesser sacrosciatic notch

Great sacrosciatic notch transmits

a—Gluteal vessels

b—Superior gluteal nerve

c—Pyriformis muscle

d—Pudic vessels and nerve

e—Sciatic vessels and nerves

f—Nerve to the obturator internus muscle

Lesser sacro-sciatic notch transmits

a—Obturator internus muscle

b—Pudic vessels (reëntering)

c—Pudic nerve (reëntering)

Tuberosity of ischium: shows

Outer lip, inner lip and 4 roughened spaces between lips

Ascending ramus

Joins with descending ramus of pubis; shows for examination: outer surface, inner surface, upper and lower borders

Pubis

Forms anterior and inner portion of os innominata

Shows

Body

Quadrilateral in shape, flattened from before backward. Shows for examination: anterior surface, posterior surface, upper, inner and outer borders

Upper border shows

1—Angle

2—Crest

3—Tuberculum pubicum (Spine)

4—Pecten ossis pubis (Ileo-pectineal line)

Horizontal ramus

Helps to form brim of true pelvis: shows for examination

a—Upper surface; shows pectineal line and eminence

b—Under surface, helps to form circumference of obturator foramen

c—Posterior surface; forms anterior boundary of pelvis

d—Outer extremity; forms pubic portion of acetabulum

Descending ramus

Joins with ascending ramus of ischium; shows for examination: outer and posterior surfaces, outer and inner borders

Difference in Sex

Female pelvis

Lighter, more slender, muscular impressions less distinct, ilia more expanded, pelvis broader. Iliac spines more widely separated, inlet larger and more circular, cavity more shallow, more capacious, outlet more expanded

BONES OF UPPER EXTREMITY

Classification

Shoulder girdle

Scapula	1
Clavicle	1
	2

Arm
- Humerus 1

1

Forearm
- Radius 1
- Ulna 1

2

Hand
- Carpus
  - Navicular (Scaphoid) 1
  - Lunate (Semilunar) 1
  - Triquetrium (Cuneiform) 1
  - Pisiform 1
  - Greater multangular (Trapezium) 1
  - Lesser multangular (Trapezoid).. 1
  - Capitatum (Os magnum)..... 1
  - Hamate (Unciform) 1

8
- Metacarpal 5
- Phalanges 14

$32 \times 2 = 64$

SCAPULA

Definition

Large flat triangular bone, extending from 2–7th rib

Anterior Surface

Concave and forms subscapular fossa; shows

1—Marginal surface from superior to inferior angle for muscle

2—Roughed oblique lines for subscapularis

3—Prominent ridge from neck, parallel to anterior border

Posterior surface

a—Supraspinatus fossa, which gives attachment to supraspinatus muscle

b—Infraspinatus fossa, for infraspinatus muscle

c—Spinous process

Prominent triangular process which crosses dorsum of scapula obliquity

d—Acromion process
Projects over glenoid fossa of bone and forms prominence of shoulder

Borders
Superior, which is short and thin; shows a notch which is converted into a foramen by the transverse ligament. Gives attachment omohyoid muscle
Axillary
Thick; gives attachment to muscles
Vertebral
Long, thin, and prominent

Angles
Angulus medialis (Superior), thin and prominent for muscular attachment
Inferior, thick, rounded for muscular attachments; corresponds to level of 7th dorsal vertebra
Angulus lateralis (External)
Shows
A—Head, which forms glenoid cavity; this is oval and its largest diameter is vertical
B—Neck, shows bony projection called coracoid process

Muscular Attachments
The scapula affords attachment to 16 muscles
Surfaces
A—Dorsal surface
a—Supra-spinatus
b—Infra-spinatus
c—Teres minor
d—Teres major
B—Costal surface
a—Subscapularis

Processes
A—Spinous and acromion
a—Trapezius
b—Deltoid
B—Coracoid
a—Pectoralis minor
b—Biceps brachii (flexor cubiti)
c—Coraco-brachialis

Borders
A—Superior border
a—Omohyoid

B—Axillary border
a—Triceps (extensor cubiti)
C—Vertebral border
a—Rhomboideus minor
b—Rhomboideus major
c—Serratus anterior (magnus)
Posterior superior angle
A—Levator (anguli) scapulae
Total 16

Articulation
Humerus and clavicle
Development: centers
1—One for the body; it appears at the 8th week of fetal life
2—Two for the coracoid process; appears during 1st year of life

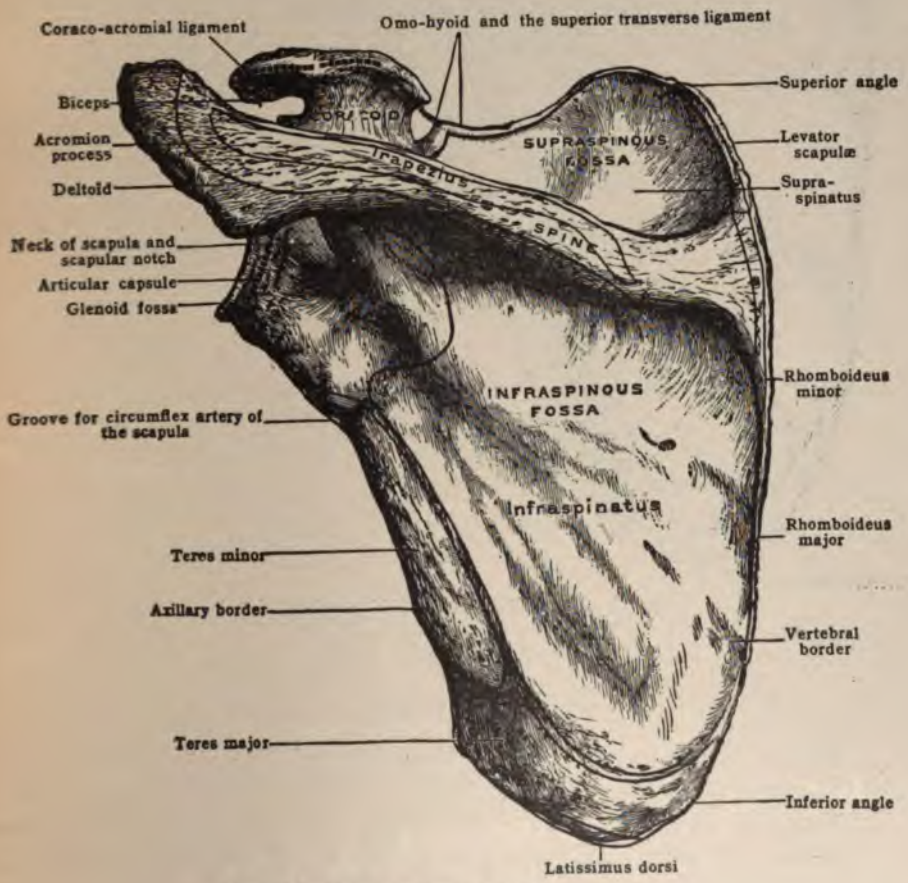


FIG. 97.—The Left Scapula (Dorsal Surface)
Morris Human Anatomy (Blakiston)

3—Two for the acromion process; appear during the 15th and 16th years
4—One for the inferior angle; appears during the 16th year
5—One for the posterior border, appears during the 17th year

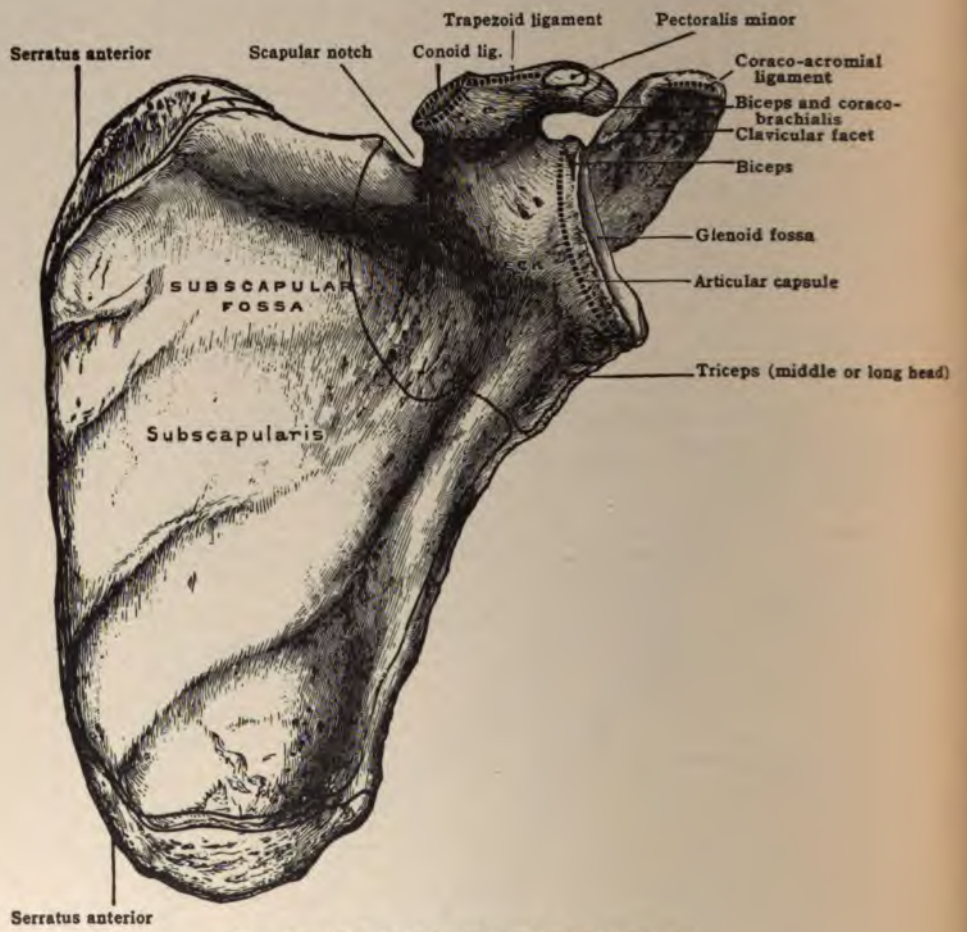


FIG. 98.—The Left Scapula (Ventral Surface)
Morris Human Anatomy (Blakiston)

CLAVICLE

Most elastic bone of the body; classed as a long bone. Shaped like the italic letter S. Convex anteriorly and rounded at inner 2/3 of bone; in its outer ⅓ anteriorly concave and flattened from above down. Presents an inner or cylindrical and an outer or flattened portion; an inner sternal and an outer acromial end

Inner or cylindrical portion

Outer border
Continuous with anterior border of flattened portion
Posterior border, from rhomboid impression to coracoidea tubercle (conoid tubercle)
Superior border
Continuous with posterior border of flattened portion
Anterior surface
Convex, continuous with upper flattened portion
Posterior surface
Concave, shows surfaces of nutrient canal
Inferior surface, presents from within out
a—Articular facet for first rib
b—Costal tuberosity (rhomboid impression) for rhomboid ligament
c—Subclavian groove for subclavian muscle

Outer or flattened portion
A—Outer border, thin and concave for attachment of the deltoid muscle
B—Posterior border, thick, convex
C—Superior surface, rough
D—Inferior surface shows coracoidal tubercle (conoid tubercle) for conoid ligament

Inner or sternal end
A—Larger than shaft, triangular, its articular facet is continuous with facet of first rib

Outer or acromial end
Flattened from above down, shows small facet for articulation with acromian process of scapula

Muscles attached
The clavicle affords attachment to 6 muscles
Anterior surface
1—Pectoralis major
2—Deltoid
Posterior surface
1—Sterno-cleido-mastoid
2—Trapezius
Lower surface
1—Subclavius
Sternal extremity
1—Sterno-hyoid

Development
Begins to ossify sooner than any other bone of body; 2 centers

Articulation

A—Sternum, scapula and 1st rib

FIG. 99.—The Left Clavicle (Superior Surface)
Morris Human Anatomy (Blakiston)

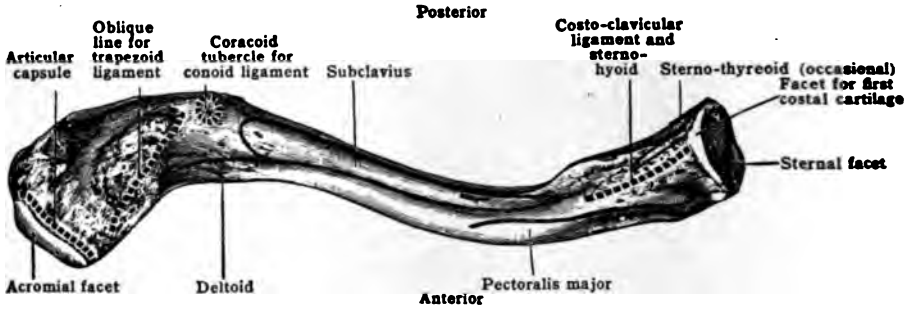


FIG. 100.—The Left Clavicle (Inferior Surface)
Morris Human Anatomy (Blakiston)

HUMERUS

Definition

Largest and longest bone of upper extremity; presents for examination upper and lower extremity and shaft

Description

Upper extremity

A—Head: represents a half-sphere; looks upward, inward, and backward; is surrounded by a constriction called the neck

B—Anatomical neck: circular in form, irregular in outline; gives attachment to capsular ligament

C—Great tuberosity: rounded eminence on outer edge of bicipital groove; presents, from before backward, 3 small facets for supra- and infraspinatus and teres minor muscles

D—Lesser tuberosity: smaller and prominent; gives attachment to subscapularis

E—Intertubercular sulcus (bicipital groove): lies between the tuberosities; is comprised in the upper 1/3 of the bone; in it glides the tendon of the long head of the biceps

F—Surgical neck: the constricted portion; joins the head to the shaft of the bone

Lower extremity

Slightly curved forward and flattened from before backward

a—Articular surface divided into

1—Radial portion which receives the head of the radius when the forearm is flexed

2—Ulnar or trochlear portion for great sigmoid cavity of ulna; in the front is a depression (coronoid fossa) which receives the coronoid process of the ulna in flexion; behind the trochlea is a depression, olecranon fossa to receive olecranon process of ulna in extension of forearm

b—Epicondyle medialis (inner condyle): a little lower than the outer condyle, and more prominent; for flexor muscles

c—Epicondyle lateralis (external condyle): higher than the inner; gives attachment to extensor muscles

Shaft

Cylindrical above; below, it is prismatic, flattened from before backward

Borders

Anterior

Extends from below the great tuberosity to the coronoid depression, forms the anterior or outer lip of the intertubercular sulcus (bicipital groove)

Internal border

Extends from the lesser tuberosity to the internal condyle, forms inner or posterior lip of intertubercular sulcus (bicipital groove)

External border

Extends from the back portion of the tuberosity to the external condyle; is crossed above by the radial (musculospinal) groove; below forms the lateral epicondyle (external condyloid ridge)

Surfaces

Internal

Shows a rough impression for coracobrachialis and a bony prominence, the supracondyloid process

External

Broader than internal

Posterior

Twisted in course, crossed by radial (musculospiral) groove

Muscles attached

The humerus affords attachment to 25 muscles

Upper third of bone

1—Greater tuberosity

A—Supraspinatus

B—Infraspinatus

C—Teres minor

2—Lesser tuberosity

A—Subscapularis

3—Bicipital groove

A—Pectoralis major

B—Latissimus dorsi

C—Teres major

Shaft of the bone

1—Deltoid

2—Coracobrachialis

3—Brachialis (anticus)

4—Triceps (extensor cubiti)

Lower third of bone

1—Inner condyle

A—Pronator (radii) teres

B—Flexor carpi radialis

C—Palmaris longus

D—Flexor sublimis digitorum

E—Flexor carpi ulnaris

2—Outer condyle and external condyloid ridge

A—Brachioradialis (Supinator longus)

B—Extensor carpi radialis longior

C—Extensor communis digitorum

D—Extensor digiti quinte proprius (extensor minimi digiti)

E—Extensor carpi ulnaris

F—Anconeus

G—Supinator (brevis)

Development

Seven centers

A—Shaft 1
B—Head 1
C—Great tuberosity 1
D—Radial articular 1

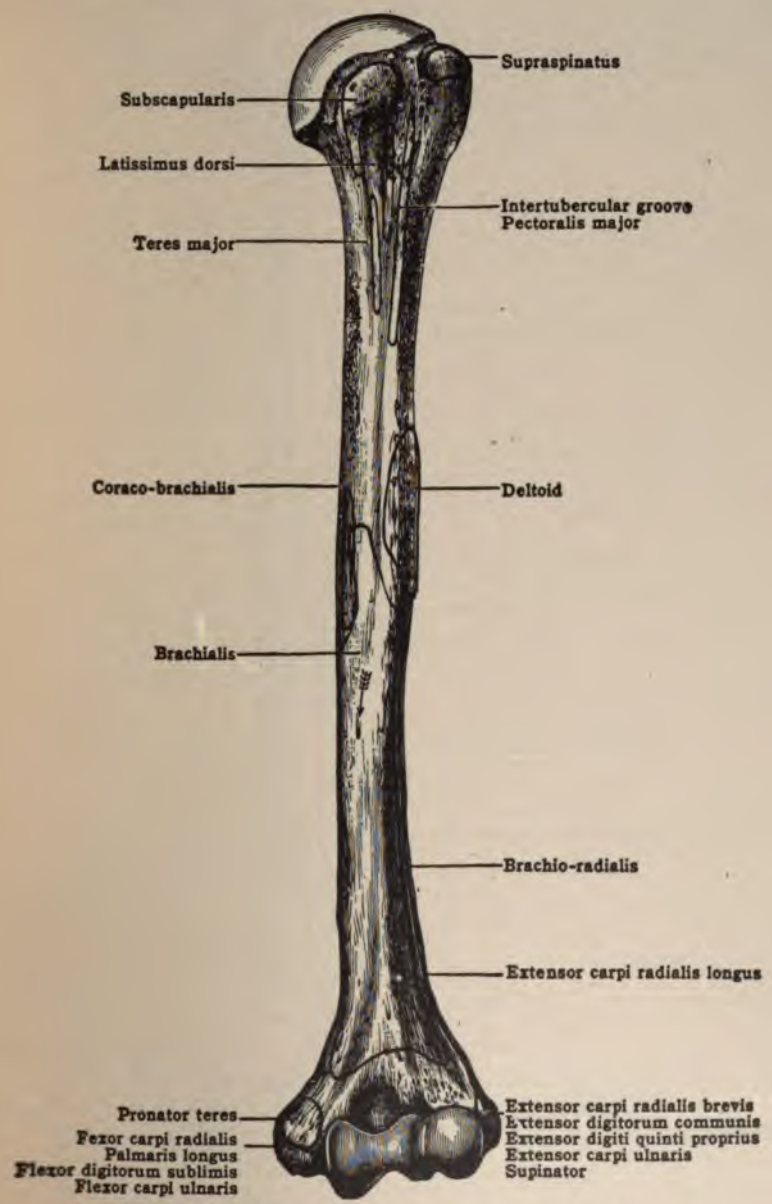


FIG. 101.—The Left Humerus (Anterior View)
Morris Human Anatomy (Blakiston)

E—Trochlear 1
F—Internal condyle 1
G—External condyle 1

7

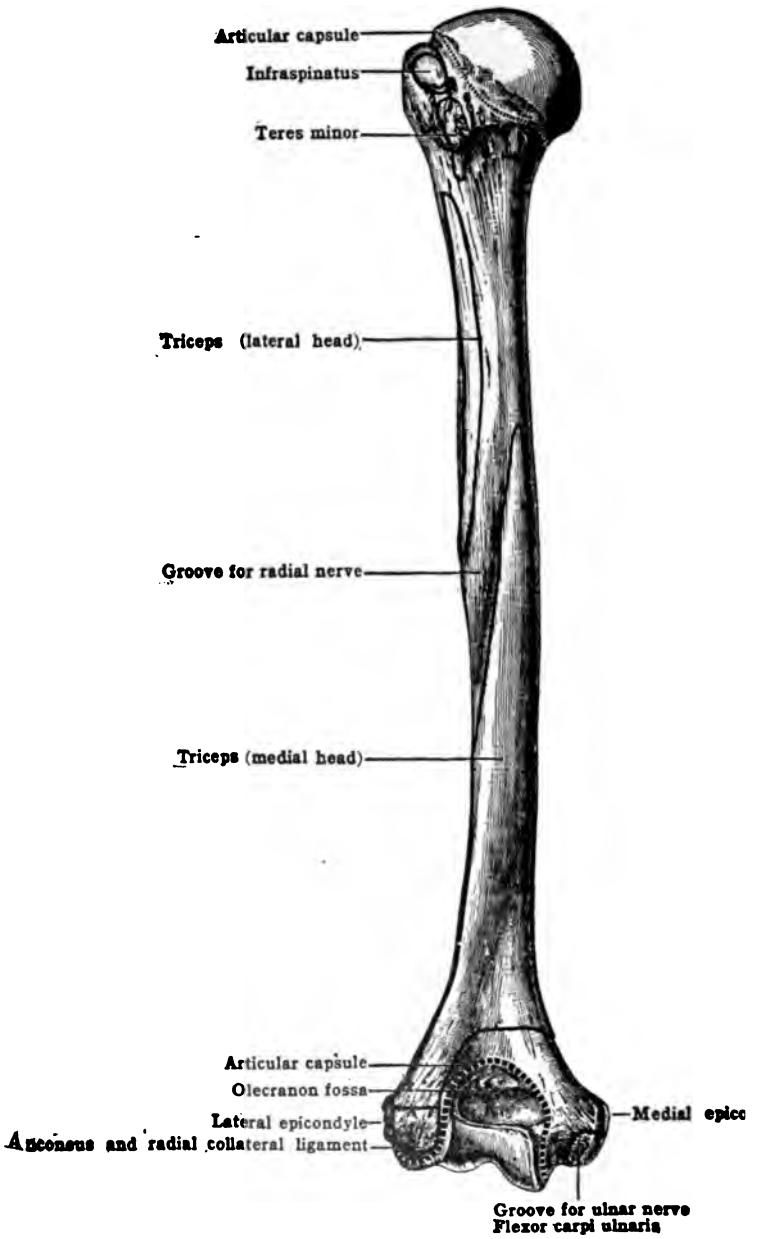


FIG. 102.—The Left Humerus (Posterior View)
Morris Human Anatomy (Blakiston)

Articulation
Scapula
Ulna
Radius

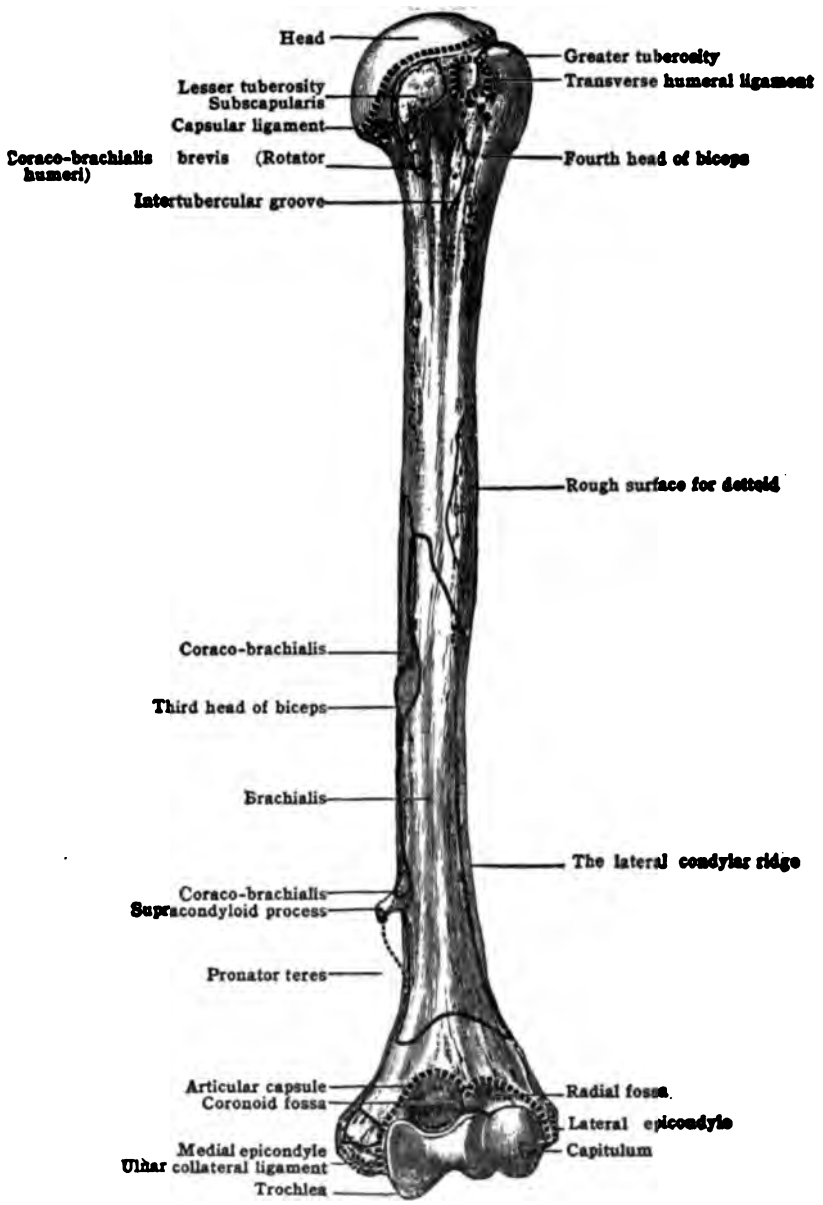


FIG. 103.—The Left Humerus with a Supracondyloid Process and Some Irregular Muscle Attachments (Anterior View)

Morris Human Anatomy (Blakiston).

ULNA

Definition

Internal bone of forearm, longer and larger than the radius

Description

Upper Extremity

Largest and strongest portion; presents

a—Coronoid process: prismatic; its apex fits into the coronoid fossa of the humerus in flexion; its base is broad and continuous with the shaft of the ulna; upper surface concave, under surface convex

b—Olecranon process, large and slightly curved; its apex fits into the olecranon fossa; the process is continuous with the shaft of the ulna. The semilunar incisive (great sigmoid) cavity between coronoid and olecranon processes; divided by a slightly elevated ridge into two parts. Radial incisive (lesser sigmoid fossa) on outer side of coronoid process, articulates with the head of the radius and is covered with cartilage

Lower extremity

Small, does not enter into formation of wrist; joint separated by fibrocartilage

Shows

1—Head: flattened; rests on triangular fibrocartilage; external surface received into lesser ulnar incisive fossa (sigmoid cavity of radius)

2—Styloid process, given off from inner and back part of head

Shaft

Large and prismatic above, becomes small and rounded below

Shows for examination

Anterior, posterior and external borders; anterior, posterior, and internal surfaces

Muscles attached

The ulna affords attachment to 13 muscles

Olecranon process

1—Extensor cubiti (Triceps)

Coronoid process

1—Brachialis anticus

2—Pronator radii teres

3—Flexor sublimis digitorum

Internal and anterior surface

1—Pronator quadratus
2—Flexor profundis digitorum
Posterior surface
1—Anconeus
2—Supinator (brevis)
3—Adductor pollicis longus (Extensor ossis metacarpi pollicis)
4—Extensor indicis
Posterior border
1—Flexor carpi ulnaris
2—Extensor carpi ulnaris

Articulation
Humerus and radius

Development
Three centers
A—Shaft 1
B—Inferior extremity 1
C—Olecranon process 1
3

RADIUS

Definition
External of the two bones of the forearm; small above where it helps to form the elbow joint; large below where it forms the wrist joint; prismatic and curved, convexity out

Description
Upper extremity
Head
Cylindrical and cup shaped, articulates with the humerus; inner surface articulates with the radial incisura (lesser sigmoid cavity of the ulna)
Neck
The constricted, rounded portion which supports the head
Tuberosity
Lower inner part of neck
Lower extremity
Large thick and quadrilateral
Inferior surface
Concave, triangular; articulates with the navicular (scaphoid) and lunate (semilunar)
Internal surface: narrow, concave; articulates with the head of the ulna

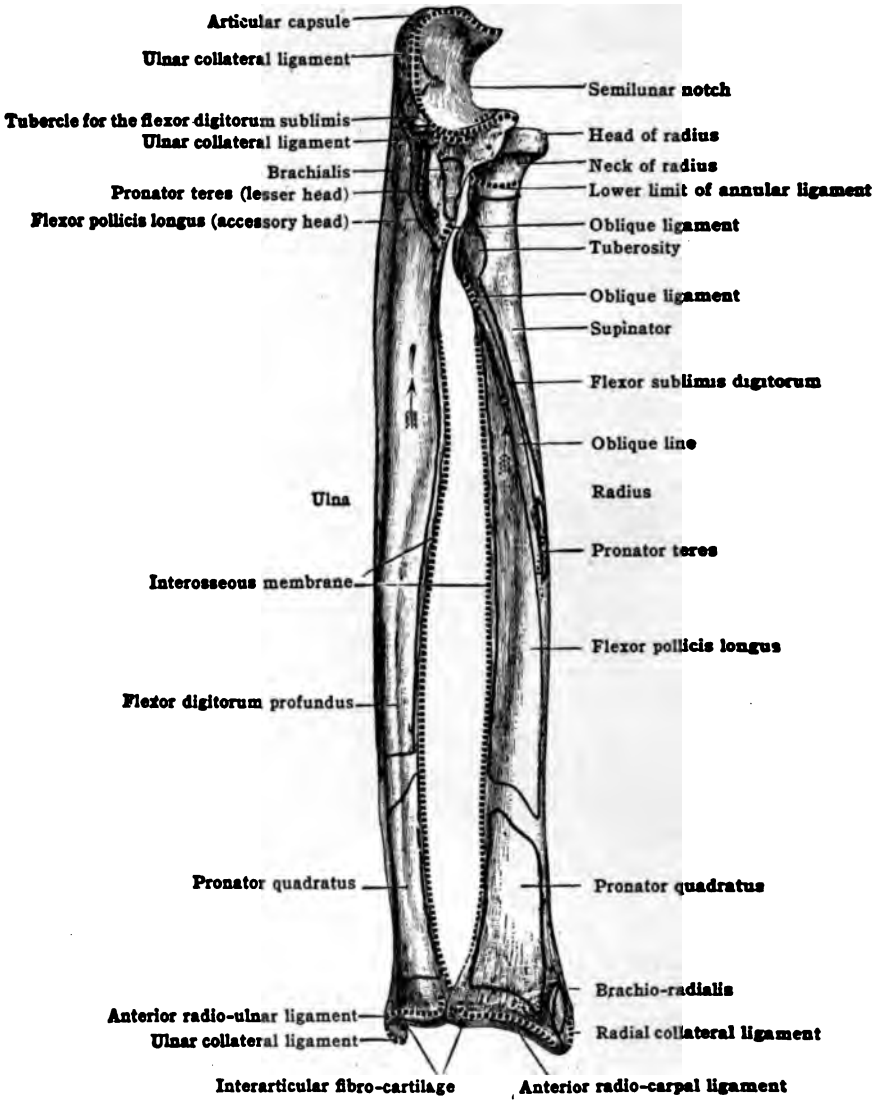


FIG. 104.—The Left Ulna and Radius (Antero-medial View)
Morris Human Anatomy (Blakiston)

External surface: prolonged downward into a bony prominence called the styloid process

Shaft

Anterior border

From the anterior tuberosity to the styloid process above, it forms the oblique line

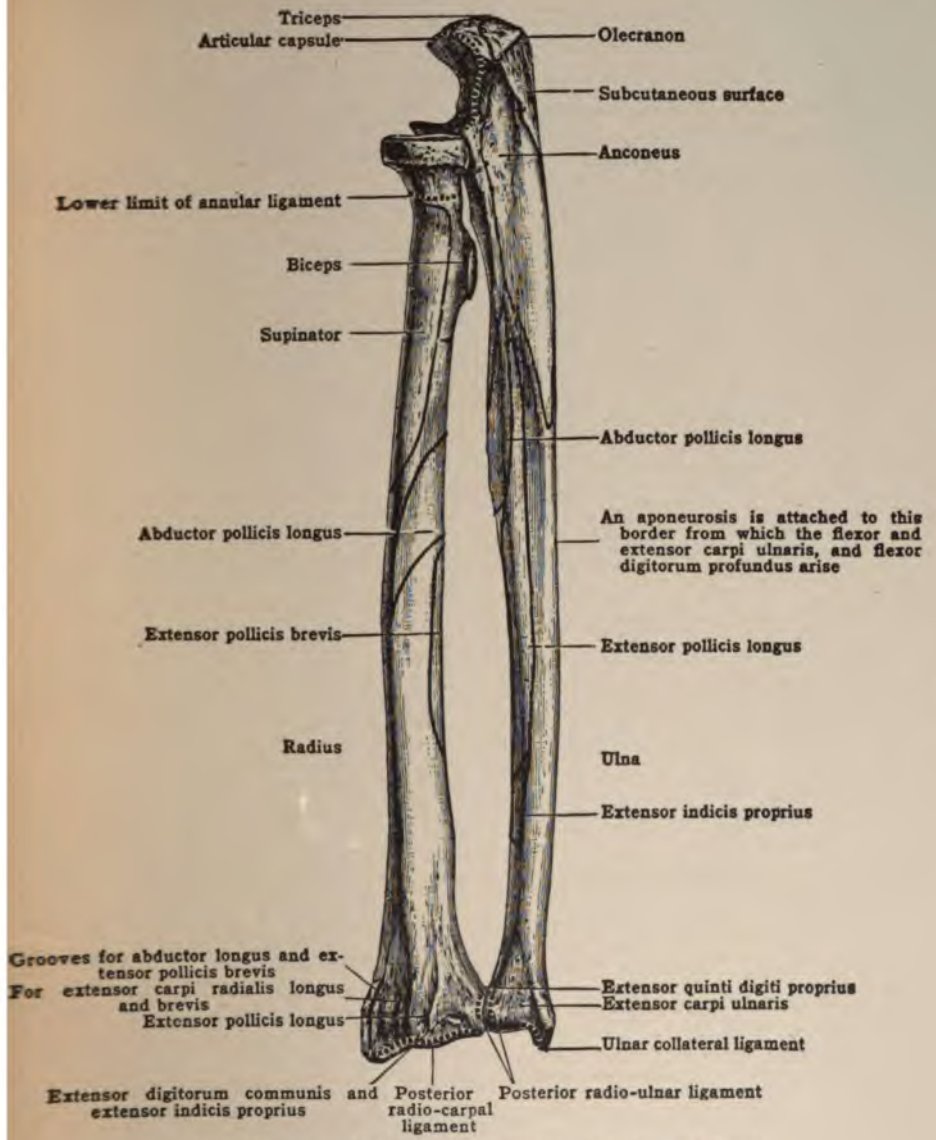


FIG. 105.—The Left Ulna and Radius (Posterior View)
Morris Human Anatomy (Blakiston)

Posterior border

From the back of the neck to the styloid process

Internal border

From back of neck of tuberosity to (sigmoid) ulnar incisure

Anterior surface
Narrow, concave
Posterior surface
Narrow, rounded in the upper portion; broad and convex in the lower portion
External surface
Convex
Muscles attached
The radius affords attachment to nine muscles
Tubercle
Biceps (flexor cubiti)
Anterior surface
Flexor sublimis digitorum
Flexor longus pollicis
Posterior surface
Adductor pollicis (extensor ossis metacarpi pollicis)
Extensor pollicis brevis (extensor primi internodii pollicis)
External border
1—Supinator (brevis)
2—Pronator (radii) teres
3—Pronator quadratus
4—Brachioradialis
Development
Centers
Shaft 1
Upper extremity 1
Lower extremity 1

CARPUS

Divided
Eight bones divided into two rows
Upper row from without inward
Navicular (scaphoid), lunate (semilunar), triquetrum (cuneiform), pisiform
Lower row
Greater multangular (trapezium), lesser multangular (trapezoid), Capitate (os magnum), hamate (unciform)
To recognize whether carpal bones belong to right or left hand
Navicular (scaphoid)
a—The largest articular facet is above

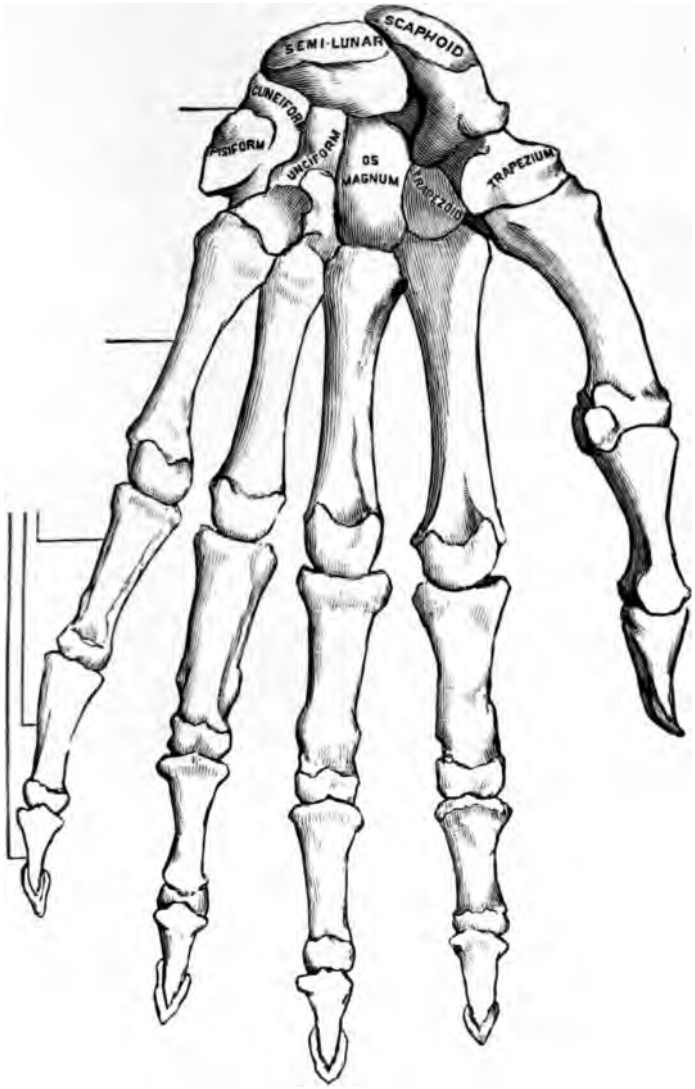


FIG. 106.—Bones of Hand (Anterior and Posterior Surface)

b—Tubercle is on its outer side
c—Transverse groove is behind

Lunate (semilunar)
a—Convex articular facet is above
b—Largest rough surface is in front
c—Semilunar facet is on its outer side

Triquetrum (cuneiform)
a—The convex surface is directed upwards

b—The flat surface lies in front
c—The small surface or angle lies on the inner side

Pisiform
a—Articular facet lies posteriorly
b—Concave surface lies on the inner side

Greater multangular (trapezium)
a—Saddle-shaped articular facet lies below
b—Ridge is directed forwards
c—Rough lateral surface is directed outwards

Lesser multangular (trapezium)
a—Saddle-shaped articular facet looks downwards
b—Large rough surface lies posteriorly
c—The projecting part lies on the inner side

Capitate (os magnum)
a—The head of the bone looks upward
b—The large rough surface lies posteriorly
c—Tubercle of the base lies on the inner side

Hamate (unciform)
a—Uncifform process lies in front and near its lower part
b—Concavity of the bone is directed outwards

METACARPAL

Definition
Five in number

Show for examination
Head: rounded at extremity; Shaft, prismoidal in shape; Base: quadilateral. Each may be recognized
A—Metacarpal of thumb: one-third shorter than rest, head less round; base: single articular facet for great multangular (trapezium)
B—Index finger: base larger, four articular facets
C—Middle finger: projecting process from radial side of base; two facets on ulnar lateral surface
D—Ring finger: base small and square, shows two small circular facets
E—Little finger: one lateral articular facet

Articulation
1st metacarpal bone
A—Great multangular (trapezium)
2nd metacarpal bone
A—Great multangular (trapezium)

B—Lesser multangular (trapezoid)
C—Capitate (os magnum)

3rd Metacarpal bone
A—Capitate (os magnum) and hamate

4th Metacarpal bone
A—3rd metacarpal
B—5th metacarpal

5th metacarpal bone
A—Hamate (unciform) and capitate

Head of each metacarpal articulates with phalanx

PHALANGES

Definition

Fourteen in number; three for each finger, two for thumb; like all long bones, show shaft and two extremities

FEMUR

Upper extremity

A—Head: forms 2/5 of sphere; presents small depression for ligamentum teres

B—Neck: portion between head and great trochanters; forms angle of 125° with shaft; quadrilateral; directed inward, upwards and forward

C—Great trochanter: large and quadrilateral, most prominent posteriorly; inner surface shows trochanteric (digital) fossa. Intertrochanteric line extends between the tuberosities

D—Lesser trochanter

Small and conical in shape

Lower extremity

Broad and expanded, divided into external and internal condyles; these are separated by depression called condyloid notch. Points of bone on either condyle called tuberosities.

Shaft

Rounded in front; behind, raised in a ridge called the linea aspera. At the lower extremity the linea aspera divides into two ridges called the external and internal epicondylic lines, which inclose a space called the popliteal space

Muscles attached

The femur affords attachment to twenty-three muscles

Attached to the great trochanter are

1—Gluteus medius

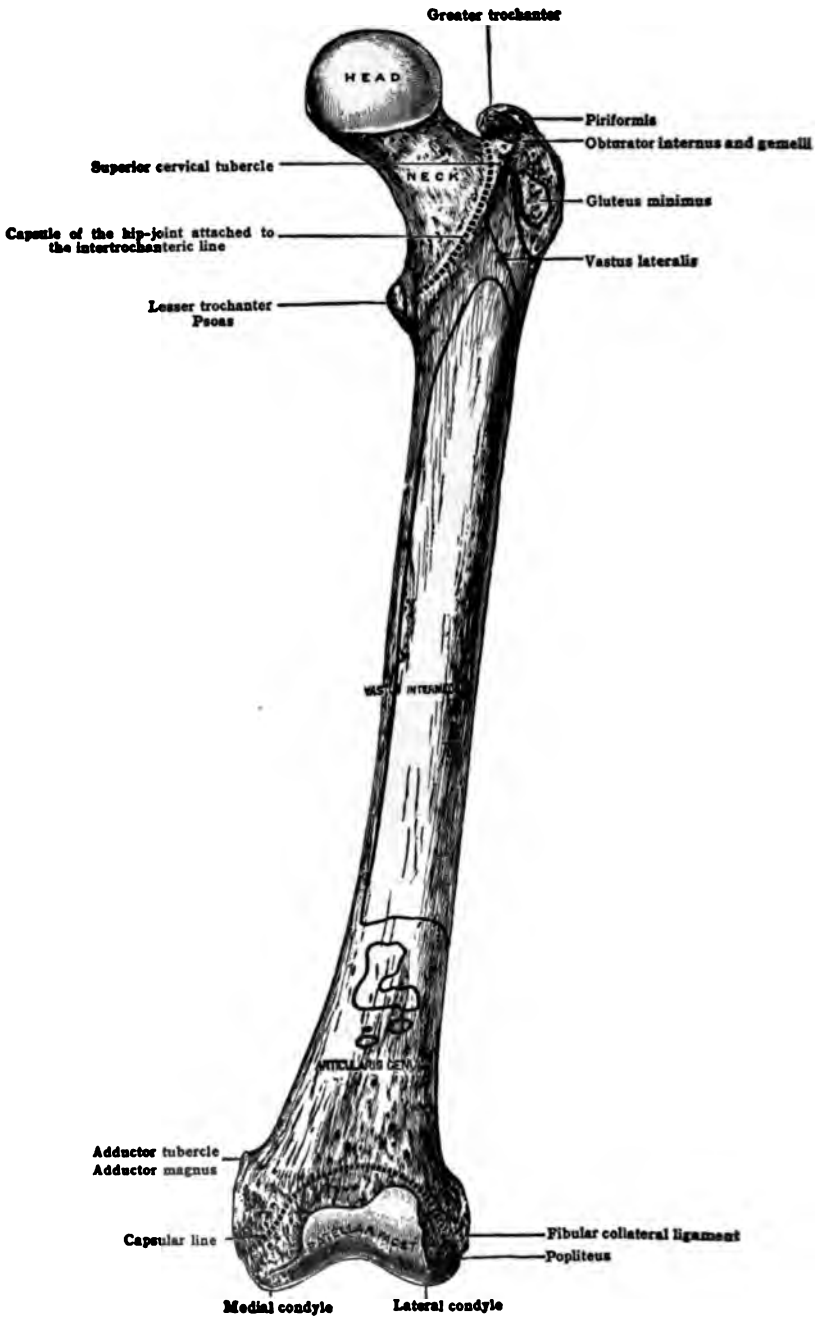


FIG. 107.—Femur (Anterior View)
Morris Human Anatomy (Blakiston)

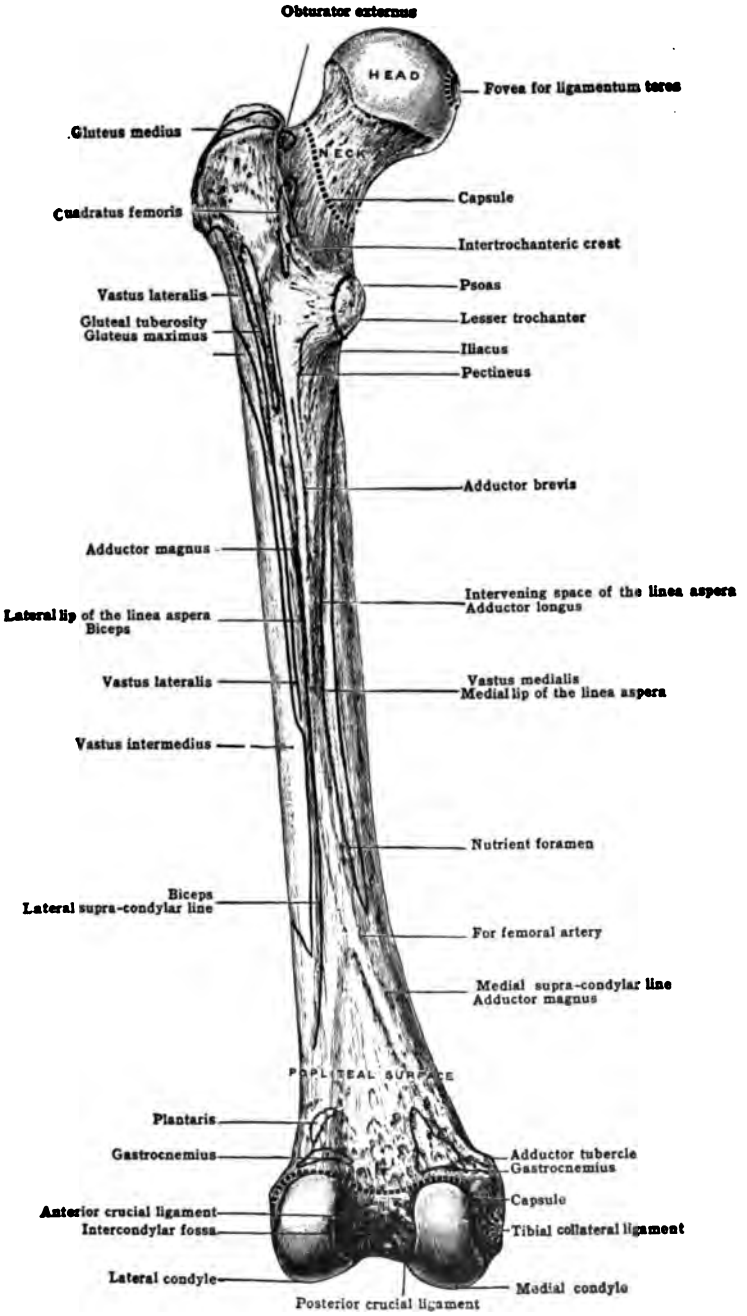


FIG. 107a.—Femur (Posterior View)

Morris Human Anatomy (Blakiston)

2—Gluteus minimus
3—Pyriformis
4—Gemellus superior
5—Obturator internus
6—Gemellus inferior
7—Obturator externus
8—Quadratus femoris

Less trochanter
1—Psoas major (magnus)
2—Iliacus

Shaft
Anterior surface
A—Vastus intermedius (crureus)
B—Articularis genu (subcrureus)
Posterior surface
Linea aspera
a—Lateralis (Vastus externus)
b—Medialis (Vastus internus)
Interstices
a—Gluteus maximus
b—Pectineus
c—Biceps femoris (flexor cruris)
d—Adductor longus
e—Adductor magnus
f—Adductor brevis
Lower fifth
A—Gastrocnemius
B—Plantaris
C—Popliteus

Articulations
Os Innominatum
Tibia and patella

Development: Centers
One for shaft and neck, appears at 5th month of fetal life
One for lower extremity, appears at 9th month of fetal life
One for head of the bone, appears at end of 1st year
One for greater trochanter, appears at 4th year
One for less trochanter, appears at 14th year

PATELLA

Triangular shaped bone, shows 2 surfaces: posterior surface has a ridge dividing it into two portions; anterior surface convex, base directed upward, apex directed downward

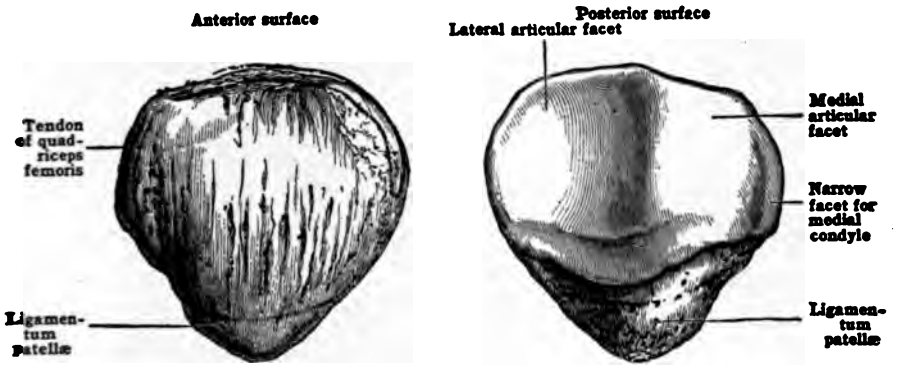


FIG. 108.—Illustration of Patella
Morris Human Anatomy (Blakiston)

TIBIA

Description
- Larger bone of leg, prismoidal in shape
  - Upper Extremity
    - Head: large size, expansions on either side called tuberosities; articulates with condyle of femur; upper surface shows a projecting portion called the intercondylar eminence (spinous process); on the anterior aspect is a tubercle for insertion of the ligamentum patella; posterior separated by notch called popliteal notch
  - Shaft
    - Shows three surfaces: inner subcutaneous, external concave, marked by deep ridge for interosseous membrane; on posterior surface oblique line called popliteal line
  - Lower extremity
    - Prolongation on inner side called medial (internal) malleolus
  - Muscular attachments
    - The tibia affords attachment for 14 muscles
      - Upper end
        - Tubercle
          - *a*—Rectus femoris
          - *b*—Vastus lateralis (externus)
          - *c*—Vastus intermedius (crureus)
          - *d*—Vastus medialis (internus)
        - Internal surface
          - *a*—Sartorius

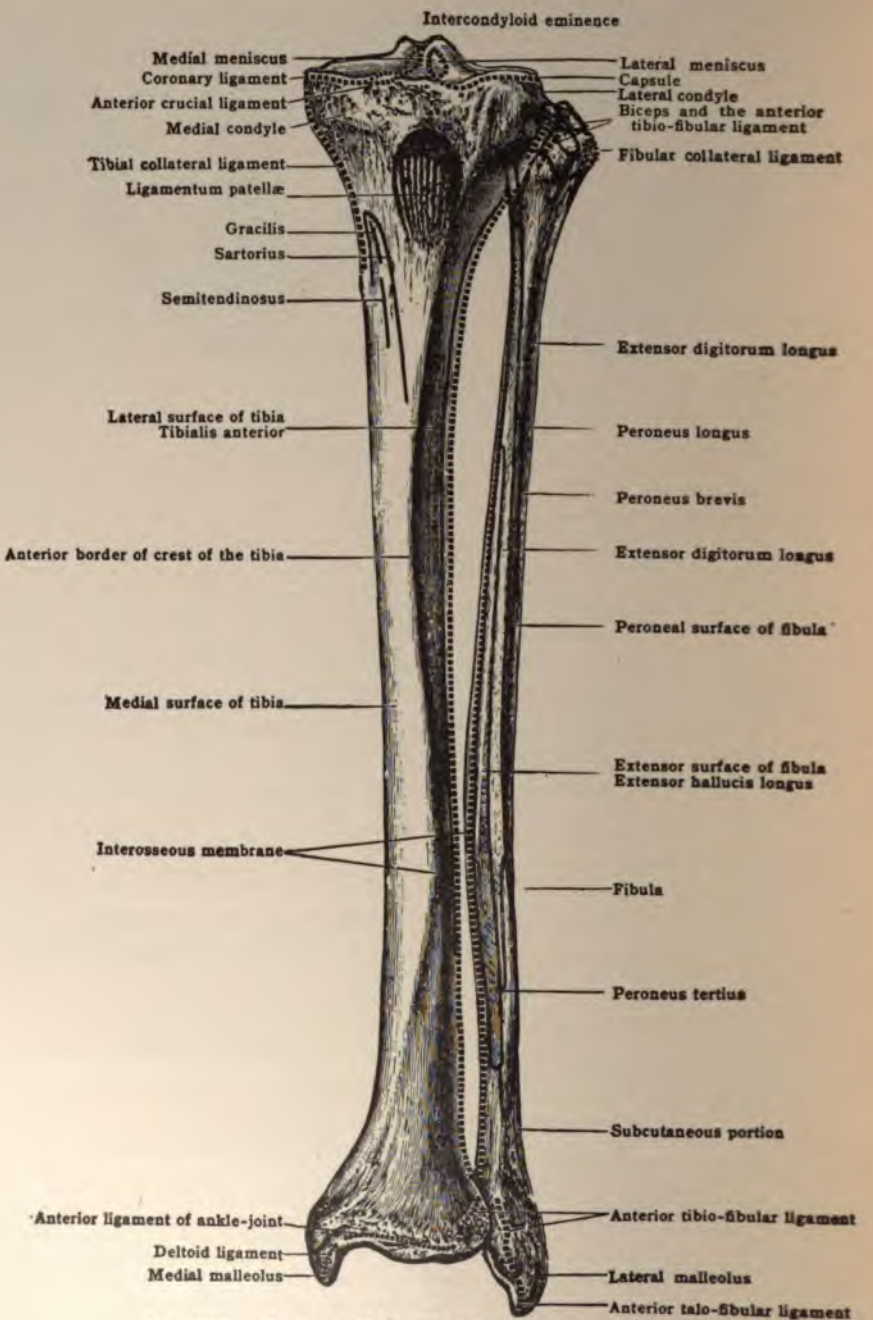


FIG. 109.—The Left Tibia and Fibula (Anterior View)

Morris Human Anatomy (Blakiston)

b—Gracilis
c—Semitendinosus
d—Semimembranosus

Shaft
External surface
a—Tibialis anterior
b—Extensor longus digitorum
Posterior surface
a—Popliteus
b—Tibialis posticus
c—Soleus
d—Flexor longus digitorum

Articulation
Femur
Fibula
Talus (astragalus)

Development
Three centers for shaft and one for each extremity

FIBULA

Description
Long and slender; prismoidal in shape
Upper extremity
Head, thick and large, marked by concave surface which articulates with external condyle (tuberosity) of tibia; styloid process for biceps muscle
Lower extremity
Forms lateral (external) malleolus
Shaft
Presents three surfaces: external, internal and posterior; also three borders
Muscular attachment
The fibula affords attachment to nine muscles
Styloid process
A—Biceps femoris (flexor cruris)
Anterior surface
A—Extensor longus digitorum
B—Extensor proprius hallucis
C—Peroneus tertius
Posterior surface
A—Soleus
B—Tibialis posticus

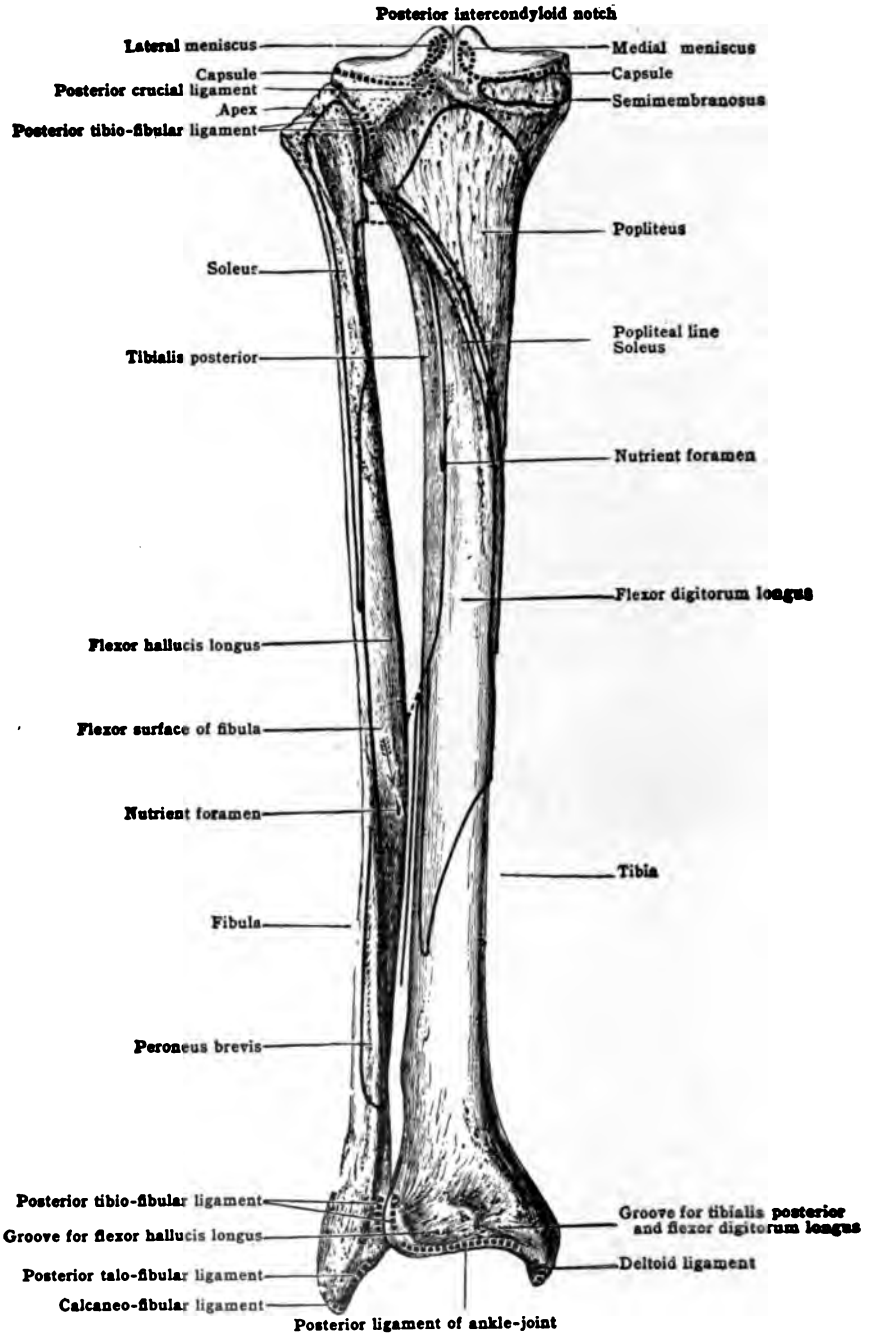


FIG. 110.—The Left Tibia and Fibula (Posterior View)
Morris Human Anatomy (Blakiston)

C—Flexor longus pollicis

External surface

A—Peroneus longus

B—Peroneus brevis

Articulation

Tibia and talus (astragalus)

Development

Three centers: one for shaft and one for each extremity

TARSUS

Talus (Astragalus)	1
Calcaneum	1
Scaphoid	1
1st, 2nd and 3rd Cuneiform	3
Cuboid	1
	7

All tarsal bones articulate with four bones, except the os calcis, which articulates with two, and the third cuneiform with six

TALUS (ASTRAGALUS)

Rounded head, broad articular facet on convex surface, two articular facets on concave surface; articulates with tibia, fibula, calcaneus (os calcis) and scaphoid

CALCANEUS (OS CALCIS)

Large size, oblong shape, six surfaces; superior, inferior, external, internal, anterior and posterior. Articulates with talus (astragalus) and cuboid

SCAPHOID

Outer surface has three facets for three cuneiform. Posterior surface articulates with talus (astragalus)

CUBOID

Three articular surfaces: anterior, posterior and internal. Three non-articular surfaces: superior, inferior and external

CUNEIFORM

Six sides and wedge shaped; all present dorsal and plantar surfaces, anterior, posterior and two lateral surfaces

METATARSAL BONES

Five long bones. Show for examination a shaft and two extremities. Shaft prismoidal, tarsal extremity (or base) square; articulates with tarsal bones and with each other; anterior extremity forms a rounded head and constricted portion (neck)

Peculiarities of metatarsals

The first metatarsal bone is shorter and larger than the rest. It forms the inner border of the foot

The second metatarsal is the longest and the largest of the remaining four; at its base it has three articular facets, since it joins with three cuneiform bones

The third metatarsal bone has two facets on the outer side of its base and is of small size

The fourth metatarsal is of small size and has a single articular facet upon each side of its base

The fifth metatarsal bone is recognized by the broad base and by the absence of an articular facet on its outer side

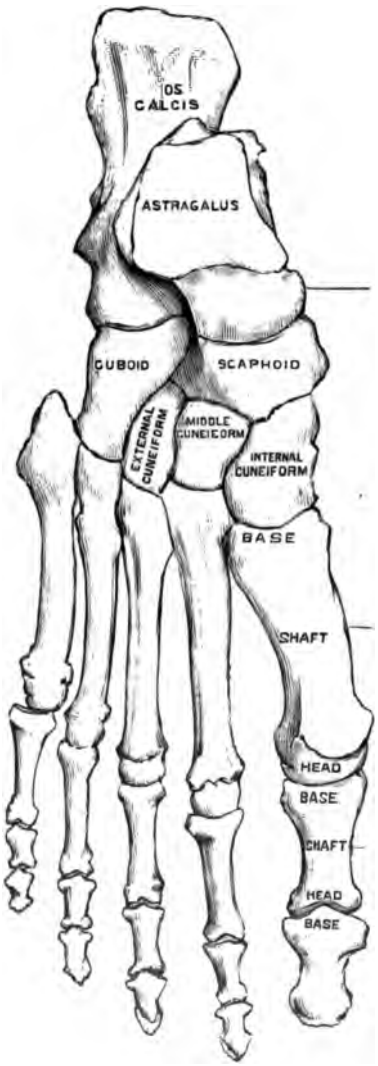


FIG. 111.—Bones of Foot (Plantar and Dorsal Surface)

PHALANGES

Fourteen in number, three for each toe and two in the big toe

JOINT

Definition

A joint is the union between the expanded extremities of bones covered with cartilage, separated by interarticular fibrocartilage held together by ligaments and lined by synovial membrane

Classification

1—Synarthrosis immovable)

A—Suture, bones interlocking with one another as in skull

B—Schindylesis, a fissure in one bone receiving a plate of bones, as between vomer and sphenoid

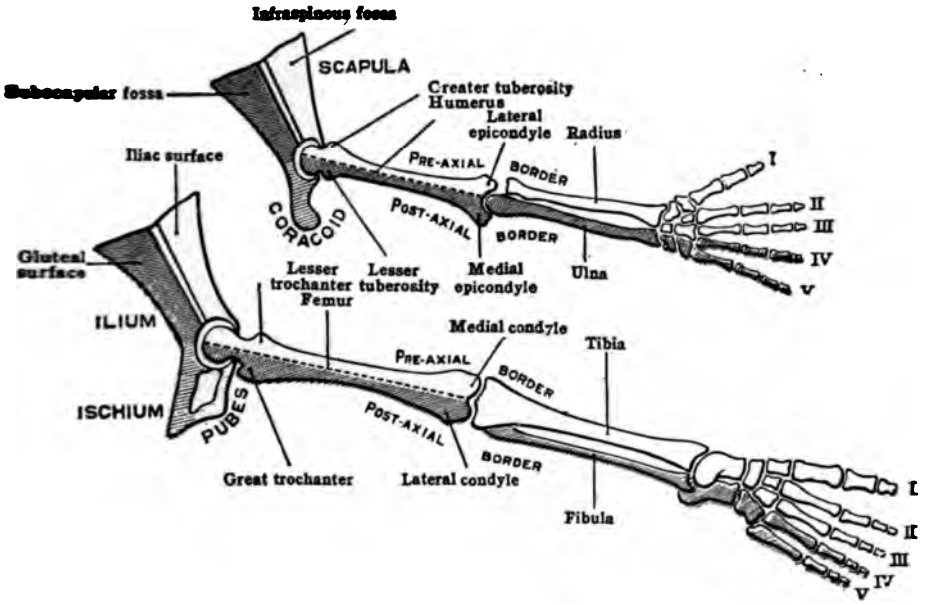


FIG. 112.—Diagrammatic Representation of the Bones of the Two Limbs, to Show Homologous Parts (modified from Flower).
Morris Human Anatomy (Blakiston)

c—Gomphosis, a socket, with a pivot inserted, as in the alveolar cavities for the teeth

D—Synchondrosis, a temporary joint in which the connecting medium is cartilage

E—Squamosa, overlaping beveled margins

F—Harmonia, formed by union of roughened surfaces, as in the intermaxillar suture

2—Diarthrosis (movable)

A—Arthrodia, gliding joint; *e.g.*, superior tibio-fibular

B—Enarthrosis, ball-and-socket joint; *e.g.*, shoulder and hip

C—Ginglymus, hinge-joint; such as knee and ankle

D—Trochoides, a ring surrounding a pivot; *e.g.*, atloaxoid joint, and superior radio-ulnar

E—Condyloid, elliptical cavity receiving an ovoid head; *e.g.*, the wrist joint

F—Reciprocal reception, a concavo-convex articulation, such as the carpo-metacarpal joint of thumb

3—Amphiarthrosis (partly movable)

A—Such as symphysis and vertebra

Structures entering into formation of a joint

1—Bones

2—Ligaments

3—Cartilages
4—Fibrocartilage
5—Synovial membrane
Movements of joint
1—Flexion
2—Extension
3—Adduction
4—Abduction
5—Rotation
6—Circumduction
7—Gliding

TEMPOROMAXILLARY

Definition
Formed by condyle of lower jaw, articulating with glenoid cavity of the temporal bone. It is a double ginglymo-arthrodial joint
Ligaments
1—Capsular
Origin
Circumference of articulation
Insertion
Neck of condyle
2—Synovial membrane
Divided into two by cartilage
3—Temporo-mandibular (external lateral)
Origin
Tubercle on outer edge of zygoma
Insertion
Outer side of neck of condyle
4—Spheno-mandibular (internal lateral)
Origin
Spinous process of sphenoid
Insertion
Neck of condyle
5—Stylo-mandibular (stylo-maxillary)
Origin
Styloid process
Insertion
Inner surface of angle of jaw
6—Interarticular fibro-cartilage
Within the cavity

Nerve supply
Derived from the auriculo-temporal and masseteric branches of the inferior maxillary
Blood supply
Internal maxillary artery

SHOULDER

Definition
Diarthrodial enarthrodial joint between head of humerus and glenoid fossa of the scapula
Ligaments
1—Capsular: from glenoid fossa to anatomical head of humerus
2—Coraco-humeral: from coracoid process to great tuberosity of humerus
3—Labrum glenoidale (glenoid ligament): fibrocartilaginous ring attached to glenoid fossa
4—Synovial membrane
Vessels
Circumflex and suprascapular
Nerves
Circumflex and suprascapular

ELBOW

Definition
Diarthrodial ginglymus joint
Composition
1—Humerus with semilunar incisure (sigmoid fossa) of ulna
2—Humerus with radius
3—Radial incisure (less sigmoid) of ulna with radius
Ligaments
1—Anterior ligament
2—Posterior ligament
3—Radial collateral (external lateral)
4—Ulnar collateral (internal lateral)
5—Synovial membrane
Blood supply
1—Profunda brachii (superior profunda)
2—Superior ulnar collateral (inferior profunda)
3—Anastomotica
4—Radial and ulnar
Nerve supply
Ulnar and musculo-cutaneous

RADIO-ULNAR

Articulation

Bones articulate at upper extremities, shafts and lower extremities

A—Superior articulation

Lateral ginglymus, between circumference of head of radius and the radial incisura (lesser sigmoid cavity) of ulna. Only one ligament, the orbicular, surrounds radius and extends to lesser sigmoid cavity of ulna

B—Middle articulation

a—Oblique or round from coronoid process of ulna to radius below tuberosity

b—Interosseous ligament between radius and ulna

C—Inferior articulation

A pivot joint formed by the head of the ulna and the sigmoid cavity of the radius

Anterior radio-ulnar ligament

Posterior radio-ulnar ligament

Triangular fibrocartilage which separates head of the ulna from the wrist joint

WRIST JOINT

Definition

A condyloid articulation formed by the lower end of the radius and the triangular cartilage of the ulna with the scaphoid, semilunar and cuneiform bone of the carpus

Ligaments

1—Radical collateral (external lateral)

2—Ulnar collateral (internal lateral)

3—Anterior ligament

4—Posterior ligament

Blood supply

Anterior and posterior carpal of radial and ulnar

Nerve supply

Ulnar

LOWER EXTREMITY

I—Coxo-femoral or hip joint

Definition

Diarthrodial, enarthrodial joint between head of femur and acetabulum of os innominatum

Ligaments

A—Labrum glenoidale (Cotyloid)

Fibrocartilaginous ring surrounds acetabulum deficient at cotyloid notch

B—Transverse, continuous with labrum glenoidale (cotyloid ligament, covers cotyloid notch)

C—Capsular, from margin of acetabulum into neck for femur

D—Iliofemoral or Y ligament, from anterior inferior spine to anterior intertrochanteric line

E—Ischiofemoral

F—Pubofemoral

G—Ligamentum teres, from depression on head of femur into cotyloid notch of acetabulum

H—Synovial membrane

Vessels

Obturator, sciatic, internal circumflex

Nerves

Great sciatic, obturator accessory, obturator and sacral plexus

II—Knee joint

Definition

Ginglymus joint between tibia, femur and patella

Ligaments

External

a—Anterior ligament or patellar

b—Oblique popliteal ligament (Posterior ligament of Winslow)

c—Fibular-collateral (internal lateral)

d—Tibial collateral (external lateral)

e—Capsular

Internal

a—Medial meniscus (internal semilunar fibrocartilages)

b—Lateral meniscus (external semilunar fibrocartilages)

c—Transverse

d—Anterior crucial

e—Posterior crucial

f—Synovial membrane

III—Tibio-fibular

Articulation

Superior

a—Anterior tibiofibular

b—Posterior tibiofibular
Middle
Interosseous membrane
Inferior
a—Anterior tibiofibular
b—Posterior tibiofibular
c—Interosseous ligament
d—Transverse

IV—Ankle
Definition
Ginglymus joint between the talus (astragalus) and the tibia and fibula
Ligament
A—Anterior
B—Posterior
C—External lateral
D—Internal lateral (deltoid)
Vessels
Malleolar branches of anterior tibial
Nerves
Anterior tibial

GLOSSARY

BONES

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
VERTEBRAE	
Fovea costalis superior	Incomplete facet for head of rib, upper
Fovea costalis inferior	Incomplete facet for head of rib, lower
Fovea costalis transversalis	Facet for tubercle of the rib
Radix arcus vertebrae	Pedicle
ATLAS	
Fovea dentis	Facet for odontoid process
EPISTROPHEUS	AXIS
Dens	Odontoid process
STERNUM	STERNUM
Corpus sterni	Gladiolus
Processus xiphoideus	Ensiform process
Incisura jugularis	Supra-sternal notch
Planum sternale	Anterior surface

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Ossa Cranii	Bones of Skull
Os Frontale	Frontal
Spina frontalis	Nasal spine
Processus zygomaticus	External angular process
Facies cerebralis	Internal surface
Facies frontalis	Frontal surface
Pars orbitalis	Orbital plate
Os Parietale	Parietal
Lineae temporales	Temporal ridges
Sulcus transversus	Groove for lateral sinus
Sulcus sagittalis	Groove for superior longitudinal sinus
Os Occipitale	Occipital
Canalis hypoglossi	Anterior condyloid foramen
Foramen occipitale magnum	Foramen magnum
Canalis condyloideus	Posterior condyloid foramen
Sulcus transversus	Groove for lateral sinus
Sulcus sagittalis	Groove for superior longitudinal sinus
Clivus	Median part of upper surface of basi-occipital
Linea nuchae suprema	Highest curved line
Linea nuchae superior	Superior curved line
Linea nuchae inferior	Inferior curved line
Os Sphenoidale	Sphenoid
Crista infratemporalis	Pterygoid ridge
Sulcus chiasmatis	Optic groove
Crista sphenoidalis	Ethmoidal crest
Spina angularis	Spinous process
Lamina medialis processus pterygoidei	Internal pterygoid plate
Lamina lateralis processus pterygoidei	External pterygoid plate
Canalis pterygoideus (Vidii)	Vidian canal
Fossa hypophyseos	Pituitary fossa
Sulcus caroticus	Cavernous groove
Conchae sphenoidales	Sphenoidal turbinal bones
Hamulus pterygoideus	Hamular process
Canalis pharyngeus	Pterygo-palatine canal

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Tuberculum sellae	Olivary eminence
Fissura orbitalis superior	Sphenoidal fissure
Os Temporale	Temporal Bone
Canalis facialis (Falopii)	Aqueduct of Fallopius
Hiatus canalis facialis	Hiatus Fallopii
Vagina processus styloidei	Vaginal process of tympanic plate
Incisura mastoidea	Digastric fossa
Impressio trigemini	Impression for Gasserian ganglion
Eminentia arcuata	Eminence for superior semicircular canal
Sulcus sigmoideus	Sigmoid fossa
Fissura petrotympanica	Glaserian fissure
Fossa mandibularis	Glenoid cavity
Semicanalis tubae auditivae	Eustachian tube
Os Ethmoidale	Ethmoid
Labyrinthus ethmoidalis	Lateral mass
Lamina papyracea	Os planum
Processus uncinatus	Uniform process
Os Lacrimale	Lachrymal Bone
Hamulus lacrimalis	Hamular process
Crista lacrimalis posterior	Lachrymal crest
Os Nasale	Nasal Bone
Sulcus ethmoidalis	Groove for nasal nerve
Maxilla	Superior Maxillary Bone
Facies anterior	Facial or external surface
Facies infratemporalis	Zygomatic surface
Sinus maxillaris	Antrum of Highmore
Processus frontalis	Nasal process
Processus zygomaticus	Malar process
Canales alveolares	Posterior dental canals
Canalis naso-lacrimalis	Lachrymal groove
Os incisivum	Premaxilla
Foramen incisivum	Anterior palatine foramen
Os Palatinum	Palate Bone
Pars perpendicularis	Vertical plate
Crista conchalis	Inferior turbinate crest
Crista ethmoidalis	Superior turbinate crest
Pars horizontalis	Horizontal plate
Os Zygomaticum	Malar Bone
Processus temporalis	Zygomatic process

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Processus fronto-sphenoidalis	Frontal process
Foramen zygomatico-orbitale	Temporo-malar canal
Foramen zygomatico-faciale	Malar foramen
MANDIBULA	
Spina mentalis	Genial tubercle or spine
Linea obliqua	External oblique line
Linea mylohyoidea	Internal oblique line
Incisura mandibulae	Sigmoid notch
Foramen manidbulare	Inferior dental foramen
Canalis mandibulae	Inferior dental canal
Protuberantia mentalis	Mental process

THE SKULL AS A WHOLE

Ossa suturarum	Wormian bones
Foveolae granulares (Pacchioni)	Pacchionian depressions
Fossa pterygo-palatina	Spheno-maxillary fossa
Canalis pterygo-palatinus	Posterior palatine canal
Foramen lacerum	Foramen lacerum medium
Choanae	Posterior nares
Fissura orbitalis superior	Sphenoidal fissure
Fissura orbitalis inferior	Spheno-maxillary fissure

UPPER EXTREMITY

CLAVICLE	CLAVICLE
Tuberositas coracoidea	Impression for conoid ligament
Tuberositas costalis	Impression for rhomboid ligament
SCAPULA	SCAPULA
Incisura scapularis	Supra-scapular notch
Angulus lateralis	Anterior or lateral angle
Angulus medialis	Superior angle
HUMERUS	HUMERUS
Sulcus intertubercularis	Bicipital groove
Crista tuberculi majoris	External lip
Crista tuberculi minoris	Internal lip

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Facies anterior medialis	Internal surface
Facies anterior lateralis	External surface
Margo medialis	Internal border
Margo lateralis	External border
Sulcus nervi radialis	Musculo-spiral groove
Capitulum	Capitellum
Epicondylus medialis	Internal condyle
Epicondylus lateralis	External condyle
ULNA	ULNA
Incisura semilunaris	Greater sigmoid cavity
Incisura radialis	Lesser sigmoid cavity
Crista interossea	External or interosseous border
Facies dorsalis	Posterior surface
Facies volaris	Anterior surface
Facies medialis	Internal surface
Margo dorsalis	Posterior border
Margo volaris	Anterior border
RADIUS	RADIUS
Tuberositas radii	Bicipital tuberosity
Incisura ulnaris	Sigmoid cavity
Crista interossea	Internal or interosseous border
Facies dorsalis	Posterior surface
Facies volaris	Anterior surface
Facies lateralis	External surface
Margo dorsalis	Posterior border
Margo volaris	Anterior border
CARPUS	CARPUS
Os naviculare	Scaphoid
Os lunatum	Semilunar
Os triquetrum	Cuneiform
Os multangulum majus	Trapezium
Os multangulum minus	Trapezoid
Os capitatum	Os magnum
Os hamatum	Unciform

LOWER EXTREMITY

OS COXAE	INNOMINATE BONE
Linea glutea anterior	Middle curved line
Linea glutea posterior	Superior curved line
Spina ischiadica	Spine of the ischium

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Incisura ischiadica major	Great sacro-sciatic notch
Incisura ischiadica minor	Lesser sacro-sciatic notch
Tuberculum pubicum	Spine of pubis
Ramus inferior ossis pubis	Descending ramus of pubis
Ramus superior ossis pubis	Ascending ramus of pubis
Ramus superior ossis ischii	Body of ischium
Ramus inferior ossis ischii	Ramus of ischium
Pecten ossis pubis	Pubic part of iliopectineal line
Facies symphyseos	Symphysis pubis
PELVIS	PELVIS
Pelvis major	False pelvis
Pelvis minor	True pelvis
Apertura pelvis minoris superior	Pelvic inlet
Linea terminalis	Margin of inlet of true pelvis
Apertura pelvis minoris inferior	Pelvic outlet
FEMUR	FEMUR
Fossa trochanterica	Digital fossa
Linea intertrochanterica	Spiral line
Crista intertrochanterica	Posterior intertrochanteric line
Condylus medialis	Inner condyle
Condylus lateralis	Outer condyle
Epicondylus medialis	Inner tuberosity
Epicondylus lateralis	Outer tuberosity
TIBIA	TIBIA
Condylus medialis	Internal tuberosity
Condylus lateralis	External tuberosity
Eminentia intercondyloidea	Spine
Tuberositas tibiae	Tubercle
Malleolus medialis	Internal malleolus
FIBULA	FIBULA
Apex capituli fibulae	Styloid process
Malleolus lateralis	External malleolus

BONES OF THE FOOT

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
TALUS	ASTRAGALUS
CALCANEUS	OS CALCIS
Tuber calcanei	Tuberosity of os calcis
Processus medialis tuberis calcanei	Inner Tuberosities of os calcis
Processus lateralis tuberis calcanei	Outer
OS CUNEIFORME PRIMUM	INNER CUNEIFORM
OS CUNEIFORME SECUNDUM	MIDDLE CUNEIFORM
OS CUNEIFORME TERTIUM	OUTER CUNEIFORM

LIGAMENTS

LIGAMENTS OF THE SPINE	
Lig. longitudinale anterius	Anterior common ligament
Lig. longitudinale posterius	Posterior common ligament
Lig. flava	Ligamenta subflava
Membrana tectoria	Posterior occipito-axial ligament
Articulatio atlanto-epistrophica	Joint between the atlas and the axis
Lig. alaria	Odontoid or check ligaments
Lig. apicis dentis	Suspensory ligament
RIBS	RIBS
Lig. capituli costae radiatum	Anterior costo-vertebral or stellate ligament
Lig. sterno-costale interarticulare	Interarticular chondro-sternal ligament
Lig. sterno-costalia radiata	Anterior and posterior chondro-sternal ligament
Lig. costoxiphoidea	Chondro-xiphoid ligaments
JAW	JAW
Lig. temporo-mandibulare	External lateral ligament of the jaw
Lig. spheno-mandibulare	Internal lateral ligament of the jaw
Lig. stylo-mandibulare	Stylo-maxillary ligament

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Upper Extremity	**Upper Extremity**
Lig. costo-claviculare	Rhomboid ligament
Labrum glenoidale	Glenoid ligament
Articulatio radio-ulnaris proximalis	Superior radio-ulnar joint
Lig. collaterale ulnare	Internal lateral ligament of elbow-joint
Lig. collaterale radiale	External lateral ligament
Lig. annulare radii	Orbicular ligament
Chorda obliqua	Oblique ligament of ulna
Articulatio radio-ulnaris distalis	Inferior radio-ulnar joint
Discus articularis	Triangular fibrocartilage
Recessus sacciformis	Membrana sacciformis
Lig. radio-carpeum volare	Anterior ligament of the radio-carpal joint
Lig. radio-carpeum dorsale	Posterior ligament of the radio-carpal joint
Lig. collaterale carpi ulnari	Internal lateral lig. of wrist joint
Lig. collaterale carpi radiale	External lateral ligament of the wrist-joint
Articulationes intercarpeae	Carpal joints
Lig. accessoria volaria	Palmar ligaments of the metacarpo-phalangeal joints
Lig. capitulorum ossium metacarpalium transversa	Transverse metacarpal ligament
Lig. collateralia	Lateral phalangeal ligaments
Lower Extremity	**Lower Extremity**
Lig. arcuatum	Subpubic ligament
Lig. sacro-tuberosum	Great sacro-sciatic ligament
Processus falciformis	Falciform process
Lig. sacro-spinosum	Small sacro-sciatic ligament
Labrum glenoidale	Cotyloid ligament
Zona orbicularis	Zonular band
Ligamentum iliofemorale	Y-shaped ligament
Lig. ischio-capsulare	Ischio-capsular band
Lig. pubo-capsulare	Pubo-femoral ligament

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Lig. popliteum obliquum	Ligament of Winslow
Lig. collaterale fibulare	Long external lateral ligament
Lig. collaterale tibiale	Internal lateral ligament
Lig. popliteum arcumatum	Arcuate popliteal ligament
Meniscus lateralis	External semilunar cartilage
Meniscus medialis	Internal semilunar cartilage
Plica synovialis patellaris	Ligament mucosum
Plicae alares	Ligamenta alaria
Articulatio tibio-fibularis	Superior tibio-fibular articulation
Lig. capituli fibulae	Anterior and posterior superior tibio-fibular ligaments
Syndesmosis tibio-fibularis	Inferior tibio-fibular articulation
Lig. deltoideum	Internal lateral ligament of ankle
Lig. talo-fibulare anterius	Anterior fasciculus of external lateral ligament
Lig. talo-fibulare posterius	Posterior fasciculus of external lateral ligament
Lig. calcaneo-fibulare	Middle fasciculus of external lateral ligament
Lig. talo-calcaneum laterale	External calcaneo-astragaloid ligament
Lig. talo-calcaneum mediale	Internal calcaneo-astragaloid ligament
Lig. calcaneo-naviculare plantare	Inferior calcaneo-navicular ligament
Lig. talo-naviculare	Astragalo-scaphoid ligament
Pars calcaneo-navicularis	Superior calcaneo scaphoid ligament
Pars calcaneocuboidea	Internal calcaneo-cuboid ligament
Ligamentum bifurcatum	

MYOLOGY

DEFINITION—The sum of knowledge regarding the muscles, which are the active organs of motion applied to levers represented by the skeleton; the movements are produced by muscular contraction

CLASSIFIED

I—Muscles of animal life (voluntary)
Under the control of the will; comprise muscles of
A—Locomotion
B—Respiration
C—Expression
II—Muscles of organic life (involuntary)
1—Heart
2—Arteries
3—Intestinal canal
4—Various organs

NOMENCLATURE

I—Named from their situations
Tibialis; Peroneus
II—Named from their form
Trapezius; Deltoid
III—Named from their function
Flexors; Extensors
IV—Named from their attachments
Sternohyoid; sternomastoid
V—Named from their divisions
Biceps; triceps

MUSCLES OF THE HEAD

A—EPICRANIAL REGION

Epicranus (Occipitofrontalis)
Origin
From the external two-thirds of the superior curved line of the occipital bone and from the superciliary ridges of the frontal bone
Insertion
Cranial aponeurosis
Nervous supply
Facial nerve and the Lesser occipital (Occipital Minor)

B—PALPEBRAL GROUP

I—Orbicularis Oculi (Orbicularis Palpebrarum)

Origin

From the internal angular process of the frontal bone and the nasal process of the superior maxillary bone

Insertion

Into the skin covering the eyelids, spreading into the forehead, temple and cheek

Action

To close the eyelids, to compress the lachrymal sac, and force the tears into the nasal duct

Nervous supply

Temporal and malar branches of the facial or seventh cranial nerve

C—ORBITAL GROUP

I—Levator Palbebrae superioris

Origin

From the sphenoid bone, in front of the optic foramen

Insertion

Into the upper border of the superior tarsus, tarsal cartilage

Nervous supply

Oculi Motor

II—Superior Rectus

Origin

From the upper margin of the optic foramen and from the sheath of the optic nerve

Insertion

Into the sclerotic coat of the eyeball

Nervous supply

Oculi motor

III—Rectus lateralis (Rectus Externus)

Origin

By two heads

a—From the outer margin of the optic foramen

b—From the inferior common tendon (ligament of Zinn) and the lower margin of the sphenoidal fissure

Insertion

Into the sclerotic coat of the eyeball between the two heads of the muscle pass the following structures

a—3rd cranial nerve

b—Nasal branch of the fifth cranial nerve

c—Sixth cranial nerve

d—Ophthalmic vein

Nervous supply
Sixth cranial nerve; abducens

IV—Rectus Medialis (Rectus internus)

Origin
From the superior common tendon (ligament of Zinn)

Insertion
Into the sclerotic coat of the eyeball

Nervous supply
Oculi Motor

V—Obliquus Superior

Origin
Above the inner margin of the optic foramen

Insertion
Into the sclerotic coat at the outer part of the globe of the eye, the tendon first passing through a pulley, near the internal angular process of the frontal bone

Nervous supply
Trochlear of fourth cranial nerve

VI—Obliquus inferior

Origin
From a depression in the orbital plate of the superior maxillary bone, external to the lacrimal groove

Insertion
Into the outer part of the sclerotic coat of the eyeball

Nervous supply
Oculomotor or third cranial nerve

D—INTERMAXILLARY REGION

I—Orbicularis oris

Is the sphincter muscle of the mouth and consists of two portions, one for each lip; these have attachments to the superior maxilla and mandible (inferior maxillary) bones. The fibers decussate at the angle of the mouth and unite with the decussating fibers of the buccinator. The fibers at the free margin of the lips are continued from one lip to the other

E—MUSCLES OF MASTICATION

I—Temporalis

Origin
From the temporal fossa and the temporal aponeurosis

Insertion
Into the coronoid process of the mandible

Nervous supply
Mandibular branch of the fifth cranial

II—Masseter

Origin

A—From the anterior two-thirds of the zygoma and from the zygomatic processes of the superior maxilla

Insertion

Into the angle of the jaw, the external surface of the ramus, and the external surface of the coronoid process of the mandible

Nervous supply

Mandibular division of the fifth cranial nerve

III—Pterygoid Lateralis (Externus)

Origin

A—From the outer surface of the external pterygoid plate and greater wing of the sphenoid

B—From the tuberosities of the palate bone and the superior maxilla

Insertion

Into a fossa on the anterior surface of the neck of the condyle, and into the edge of the interarticular cartilage

Nervous supply

Mandibular division of the fifth cranial nerve

The internal maxillary artery passes between its two heads

IV—Pterygoid Internus

Origin

A—From a fossa between the two pterygoid plates of the sphenoid bone

B—From the hamular process of the sphenoid bone

C—From the tuberosity of the palate bone

Insertion

Into the angle and inner surface of the lower jaw as high as the dental foramen

Nervous supply

A branch from the anterior division of the mandibular nerve

V—Buccinator

Origin

A—From the outer surface and border of the alveolar process of the superior maxillary bone

B—From the mandible, from the first molar tooth to the last

C—From the pterygo-maxillary ligament

Insertion

Into the angle of the mouth, its fibers blending with those of the orbicularis oris

Action

It presses the cheeks inward to assist in articulation, mastication, blowing or sucking

Nervous supply

The facial nerve or seventh cranial and the buccal branch of the mandibular nerve

The function of the muscles of mastication:

The temporalis and masseter tend to shut the lower jaw tightly upon the upper jaw. Used in biting. The internal pterygoid and external pterygoid tend to create a horizontal motion of the lower jaw when acting alternately upon either side and not conjointly. Used for grinding food. The Buccinator keeps the food between the teeth

MUSCLES OF THE NECK

A—STERNO-CLEIDO-MASTOID

Origin

From the inner third of the clavicle and by a tendon from the upper part of the sternum

Insertion

Into the mastoid process of the temporal bone and superior nuchal line of the occipital bone

Nervous supply

Spinal accessory (11th cranial nerve)

B—OMOHYOID

Origin

From the upper border of the scapula, near the suprascapular notch

Insertion

Into the lower border of the body of the hyoid bone

Nervous supply

From three sources: viz., the hypoglossal or twelfth cranial, a filament from the vagus (pneumogastric) or tenth cranial nerve, and a filament from the cervical plexus of nerves

It is thus associated with

A—Movement of the tongue

B—Function of respiration

C—Movements of muscles of the neck

C—DIGASTRIC

Origin

The posterior belly arises from the digastric groove, on the inner side of the mastoid process of the temporal bone, and the

anterior belly from the fossa on the inner side of the symphysis of the mandible

Insertion

The central tendon is attached to the body and greater cornu of the hyoid bone, by a broad band of aponeurotic fibers in the form of a loop; this is lined by a synovial membrane. The posterior belly passes through the stylohyoid muscle

Nervous supply

The posterior belly is supplied by the facial nerve or the 7th cranial, and the anterior belly by the mylohyoid branch of the inferior dental nerve

MUSCLES OF THE ABDOMEN

SUPERFICIAL GROUP

I—Rectus abdominis

Origin

Arises by two tendons, one being attached to the crest of the pubis and the other to the ligament covering the symphysis pubis

Insertion

A—Into the xiphoid cartilage and the costoxiphoid ligaments

B—Into the cartilage of the fifth, sixth and seventh ribs

Nervous supply

Lower intercostal nerves

II—Obliquus abdominis externus (external or descending oblique)

Origin

Eight fleshy digitations from the external surface and lower borders of the lower eight ribs

Insertion

A—By fleshy fibers, into the anterior-half of the outer lip of the crest of the ilium

B—Into the entire length of the linea alba by means of an aponeurosis

C—By the Inguinal (Poupart's) and Lacunar (Gimbernat's) ligaments into the spine of the pubis and into about one inch of the pectineal line

Nervous supply

Lower intercostal nerves

Action

To depress the ribs; to compress the viscera; to raise the pelvis when the thorax is fixed, or to flex the spine, when the pelvis is made the fixed point

III—Obliquus abdominis internus

Origin

A—From the external half of the inguinal ligament

B—From the anterior two-thirds of the middle lip of the crest of the ilium

C—From the posterior layer of the fascia lumborum

Insertion

A—By fleshy fibers into the lower borders of four inferior costal cartilages

B—Into the linea semilunaris and linea alba

C—Into the body of the pubis and the pectineal line in common with the fibers of the transversalis muscle, thus forming the so-called "conjoined tendon"

Nervous supply

Ilio-hypogastric and ilio-inguinal nerves

IV—Transversalis abdominis

Origin

A—From the external one-third of the inguinal ligament

B—From the anterior three-fourths of the internal lip of the crest of the ilium

C—From the fascia lumborum

D—From the inner surfaces of cartilages of the lower six ribs

Insertion

A—Into the linea semilunaris and the linea alba. After joining with the posterior lamella of the aponeurosis of the internal oblique muscle

B—Into the crest of the pubis, the pubic and inguinal ligaments, and the linea pectinea (thus helping to form the conjoined tendon)

C—The internal portion of the muscle passes behind and beneath the spermatic cord, and is inserted into the inguinal ligament

Nervous supply

Lower intercostal nerves

V—Cremaster

Origin

From the middle portion of the inguinal ligament behind the pubic insertion of that ligament

Insertion

By successive loops the spermatic cord is surrounded as well as the testicle and the tunica vaginalis

Nervous supply

Genitofemoral (Genitocrural)

Action

To suspend the testes

DEEP GROUP

I—Psoas Minor (Psoas Parvus)

Origin

A—From the body of the last dorsal and the first lumbar vertebra

B—From the corresponding inter-vertebral discs

Insertion

A—Into the iliopectineal eminence

Nervous supply

The anterior rami of the lumbar nerves

II—Psoas Major (Psoas Magnus)

Origin

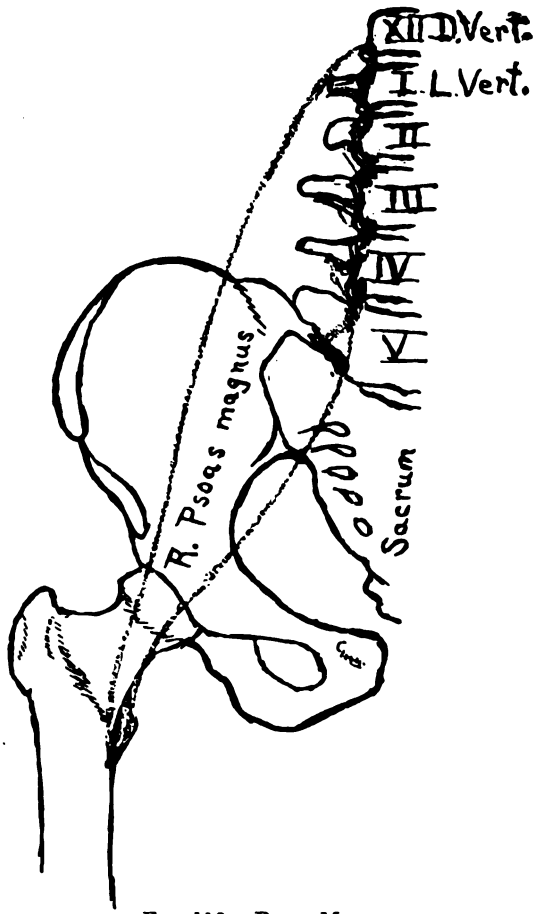


FIG. 113.—Psoas Magnus

A—By five slips from the sides of the bodies of the last dorsal and all the lumbar vertebrae and from the corresponding intervertebral discs

Insertion

Into the lesser trochanter of the femur

Nervous supply

The anterior rami of the lumbar nerves

III—Iliacus

Origin

A—From the iliac fossa—and the inner lip of the crest of the ilium

Insertion

A—Into the lesser trochanter of the femur in common with the tendon of the psoas major muscle

B—Into a line running from the lesser trochanter to the linea aspera

Nervous supply

An intrapelvic branch of the femoral nerve (Anterior crural)

MUSCLES OF THE THORAX

DIAPHRAGM

This muscle forms the dividing septum between the cavities of the thorax and abdomen. It is formed like a dome during the passive condition, as its central tendon is situated much higher than its circumferential attachment; but during its contraction, it is nearly a flat plane

Origin

In front

From the xiphoid cartilage (ensiform cartilage).

Laterally

Inner surface of the costal cartilages. Bony portions of the seven lower ribs (interdigitating with the transversalis abdominalis)

Posteriorly

Ligamentum arcuatum externum

Ligamentum arcuatum internum

Lumbar vertebrae

Insertion

Into the centrum tendinum (central tendon of the diaphragm)

Nervous supply

Phrenic nerve. A branch of the cervical plexus

MUSCLES OF THE BACK

A—TRAPEZIUS

Origin

1—From the ligamentum nuchae and the corresponding portion of the supraspinous ligament

2—From spinous processes of the seventh cervical to the twelfth dorsal vertebra inclusive

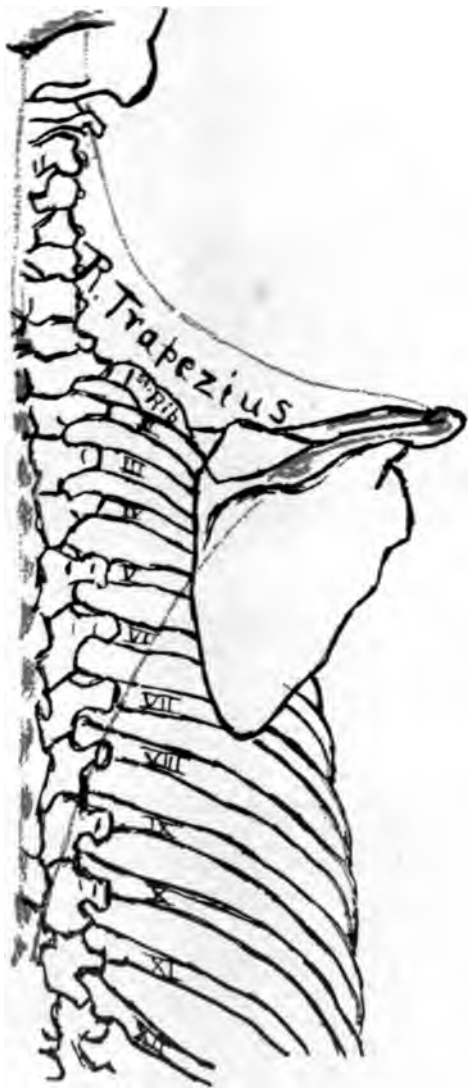


FIG. 114.—Trapezius

3—From the inner one-third of the superior nuchal line of the occipital bone

Insertion

1—Into the spine of the scapula

2—Into the acromion process

3—Into the external third of the clavicle

Nervous supply

Spinal accessory or eleventh cranial nerve and the deep branches of the cervical plexus

The lower border of the trapezius may be defined by a line drawn from the spine of the scapula to the spine of the last dorsal vertebra

B—LATISSIMUS DORSI

Origin

1—From the spinous processes of the lower six dorsal vertebrae and the supraspinous ligament

2—From the spinous processes of the lumbar vertebrae and the sacrum

3—From the posterior one-third of the outer lip of the crest of the ilium

4—From the last four ribs by fleshy digitations

Insertion

Into the bottom of the inter-tubercular sulcus (bicipital groove) of the humerus

Nervous supply

Thoracodorsal (long subscapular) nerve from the brachial plexus

The upper border of the latissimus dorsi may be defined by a line drawn from the spine of the sixth dorsal vertebra in a horizontal direction over the inferior angle of the scapula

MUSCLES OF THE UPPER EXTREMITY

A—THORACIC

I—Pectoralis major

Origin

A—From the inner half of the clavicle

B—From the corresponding half of the front of the sternum

C—From the cartilages of the true ribs

D—From the aponeurosis of the obliquus externus

Insertion

Into the anterior lip of the intertubercular sulcus of the humerus (bicipital groove)

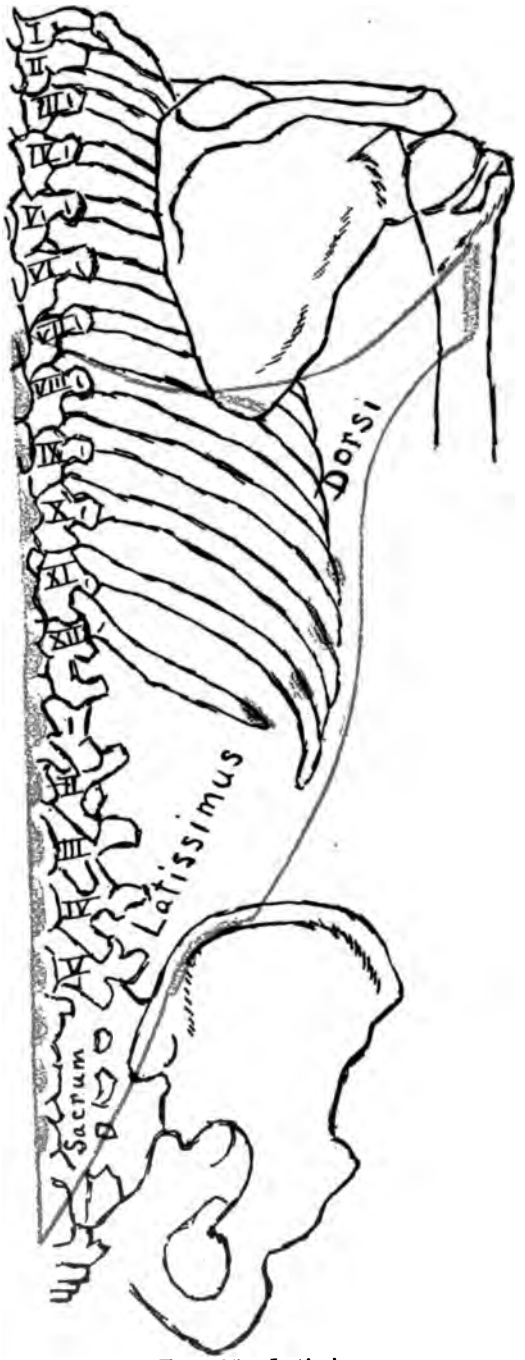


FIG. 115.—Latissimus

Nervous supply

From the anterior thoracic branches of the brachial plexus of nerves

II—Pectoralis minor

Origin

From the outer surface and the upper border of the third, fourth and fifth ribs near their cartilages and from the aponeurosis covering the intercostal muscles

Insertion

Into the inner border of the coracoid process of the scapula

Nervous supply

Both anterior thoracic branches of the brachial plexus

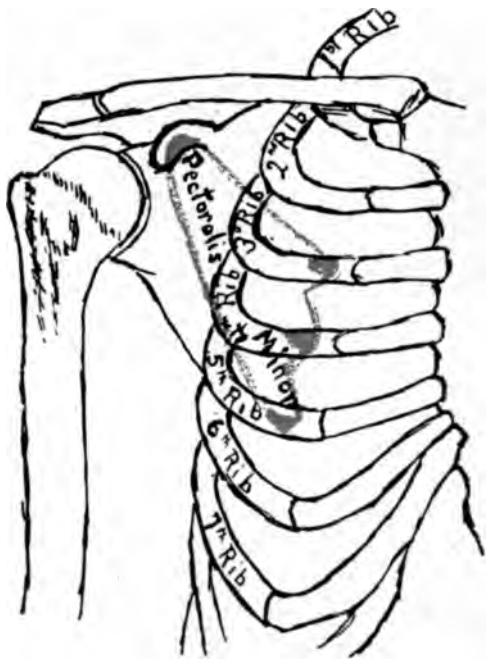


FIG. 116.—Pectoralis Minor

III—Subclavius

Origin

From the cartilages of the first rib in front of the costoclavicular (rhomboid) ligament of the clavicle

Insertion

Into a groove on the under surface of the middle third of the clavicle

Nervous supply

Nerve to the subclavius (supraclavicular) branch of the brachial plexus

IV—Serratus anterior (serratus magnus)

Origin

By nine fleshy digitations from the outer surface and the upper border of the eight upper ribs (the 2nd rib having two digitations)

Insertion

Into the ventral aspect of the vertebral border of the scapula

Nervous supply

The long thoracic nerve

B—SHOULDER

I—Deltoid

Origin

A—From the upper surface and outer half of the clavicle

B—From the outer border of the acromion process of the scapula

C—From the whole length of the spine of the scapula

Insertion

Into a rough, triangular prominence a little above the middle of the outer surface of the humerus

Nervous supply

Axillary (circumflex) nerve

II—Supraspinatus

Origin

A—From the inner two-thirds of the supra spinous fossa of the scapula

B—From the fascia which covers it

Insertion

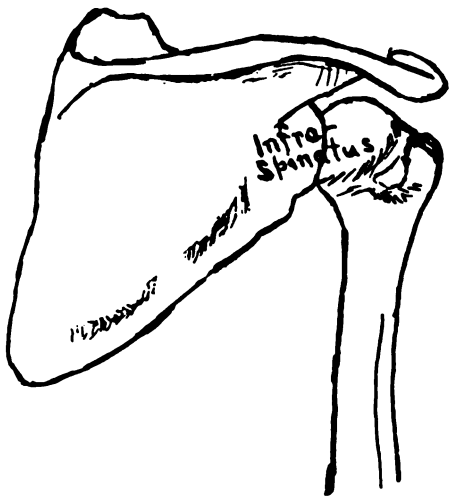


FIG. 117.—Infraspinatus

Into the highest of the three facets upon the greater tuberosity of the humerus

Nervous supply

Suprascapular nerve

III—Infraspinatus

Origin

From the inner two-thirds of the infraspinatus fossa of the scapula

Insertion

A—Into the middle facet upon the greater tuberosity of the humerus

B—By a few fibers occasionally into the neck of the humerus

Nervous supply

Suprascapular (Circumflex)

IV—Teres major

Origin

A—From the dorsal aspect of the lower angle of the scapula

B—From the intermuscular septum which separates it from the teres minor and the infraspinatus muscles

Insertion

Into the posterior lip of the intertubercular sulcus of the humerus (bicipital groove)

Nervous supply

Lower subscapular nerve

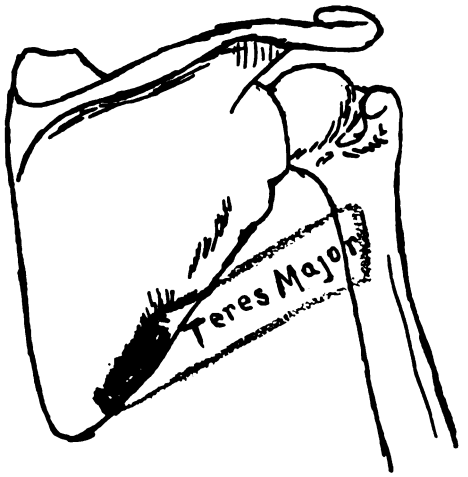


FIG. 118.—Teres Major

V—Subscapularis

Origin

From the inner two-thirds of the subscapular fossa

Insertion

Into the lesser tuberosity of the humerus

Nervous supply

Short subscapular and lower subscapular nerves

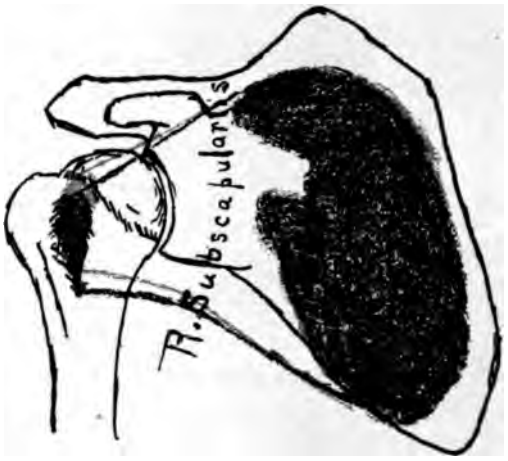


FIG. 119.—Subscapularis

C—MUSCLES OF THE ARM

I—Biceps brachii (Biceps flexor cubiti)

Origin

Short head: from the tip of the coracoid process of the scapula in common with the coraco-brachialis muscle

Long head: from the top of the glenoid cavity of the scapula

Insertion

Into the posterior aspect of the tuberosity of the radius (bicipital tuberosity)

Nervous supply

Musculo cutaneus nerve

II—Brachialis (Brachialis anticus)

Origin

A—From the lower half of both the inner and outer surfaces of the shaft of the humerus

B—From an internal and external intermuscular septum

Insertion

Into the coronoid process of the ulna

Nervous supply

The musculocutaneus nerve and a filament of the radial nerve (musculospiral)

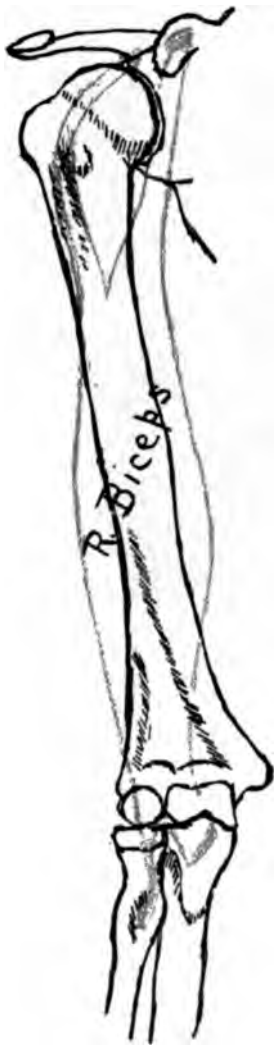


FIG. 120.—Biceps Flexor Cubiti

FIG. 121.—Brachialis Anticus

III—Coracobrachialis

Origin

From the tip of the coracoid process of the scapula in common with the short head of the biceps

Insertion

Into a rough ridge situated a little above the middle of the inner surface of the shaft of the humerus

Nervous supply

The musculo cutaneous nerve

FIG. 122.—Triceps

FIG. 123.—Pronator Teres

IV—Triceps (Triceps extensor cubiti)

Origin

Long head

a—From a depression below the glenoid cavity

Lateral head

a—From the posterior surface of the shaft of the hu-

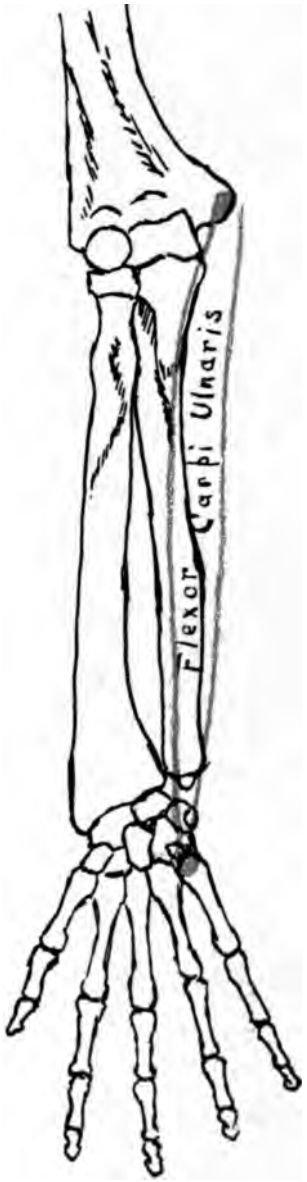


FIG. 124.—Flexor Carpi Ulnaris

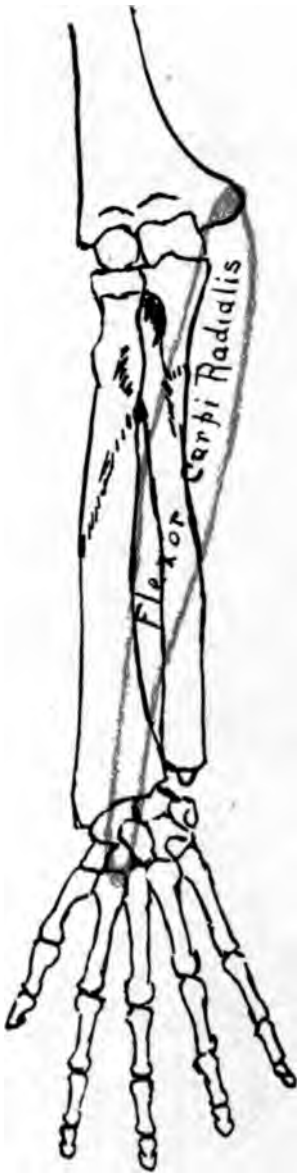


FIG. 125.—Flexor Carpi Radialis

merus above the radial groove (muscular spiral groove)

Medial head

a—From the posterior surface of the shaft of the humerus below the radial groove

b—From the inner border of the humerus

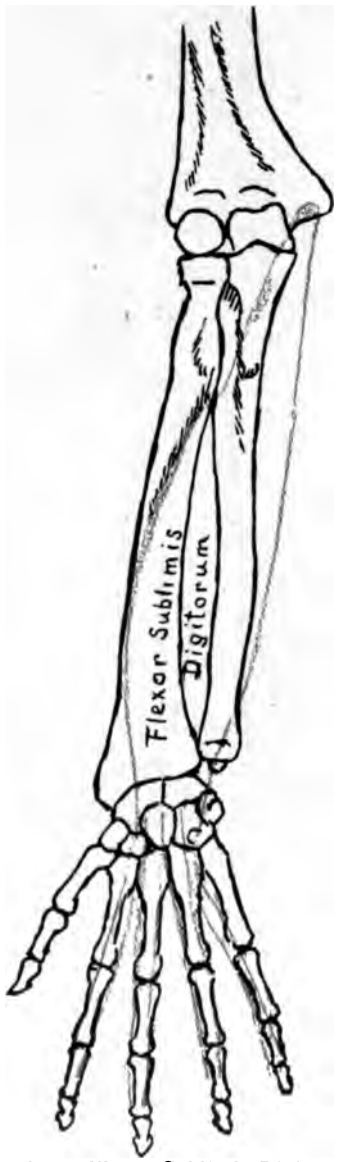


FIG. 126.—Flexor Sublimis Digitorum

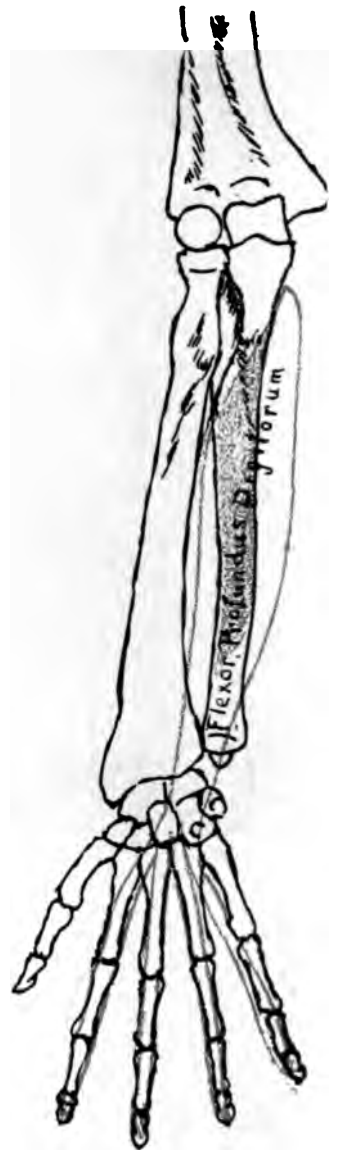


FIG. 127.—Flexor Profundus Digitorum

c—From the internal intermuscular septum

Insertion

Posterior and upper part of the olecranon process (ulna

Nervous supply

Radial (Musculospiral) nerve

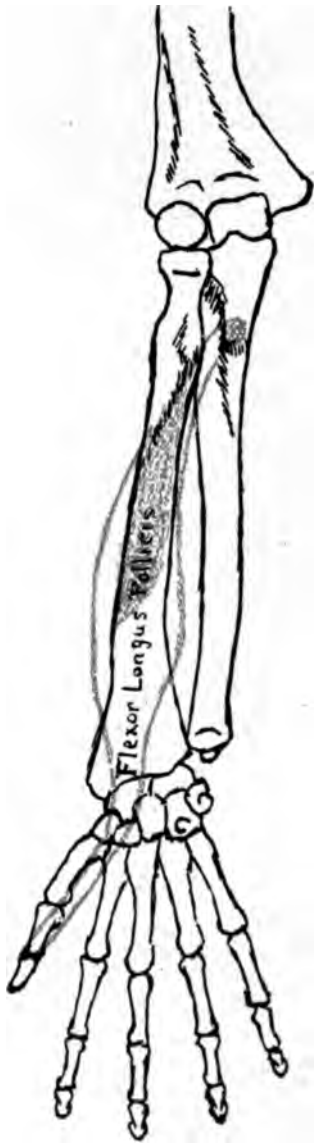


FIG. 128.—Flexor Longus Pollicis

FIG. 129.—Pronator Quadratus

C—MUSCLES OF THE FOREARM

Anterior radio-ulnar group

Superficial

A—Pronator teres (pronator radii teres): from the internal condyle, coranoid process and intermuscular septum; into the middle of the shaft of the radius

FIG. 130.—Brachioradialis (Supinator Longus)

B—Flexor carpi ulnaris: from the internal condyle; into the fifth metacarpal, the transverse carpal ligament (annular) and the hamulus of the os hamatum

C—Flexor carpi radialis: from the internal condyle; into the metacarpal of the index finger

D—Flexor digitorum sublimis: from the internal condyle; into the second phalanges by four tendons

E—Palmaris longus: from the internal condyle into the transverse carpal ligament (annular ligament) and palmar fascia

Deep group

D—Flexor digitorum profundus: from the internal condyle: and the shaft of the ulna into the last phalanges by four tendons

B—Flexor pollicis longus: from the shaft of the radius into the last phalanx of the thumb

C—Pronator quadratus: from the lower fourth of the ulnar into the lower fourth of the radius

Radial regions

1—Brachioradialis (supinator longus). From the external condyle of the humerus into the styloid process of the radius

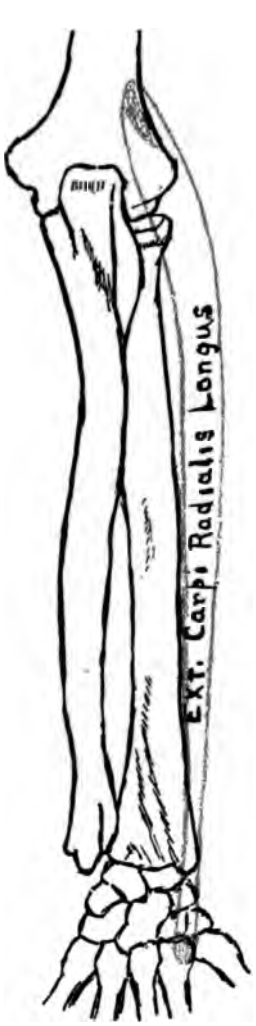


FIG. 131.—Extensor Carpi Radialis Longus

FIG. 132.—Ext. Carpi Radialis Brevis

2—Extensor carpi radialis longus from the lower third of the external condyloid ridge of the humerus; into the base of the second metacarpal bone

3—Extensor carpi radialis brevis: from the external condyloid ridge of the humerus into the base of the third metacarpal

Posterior radio-ulnar region

1—Extensor communis digitorum: from the external condyle of the humerus into all of the second and third phalanges

2—Extensor digiti quinti proprius (extensor minimi digiti):

FIG. 133.—Extensor Communis Digitorum

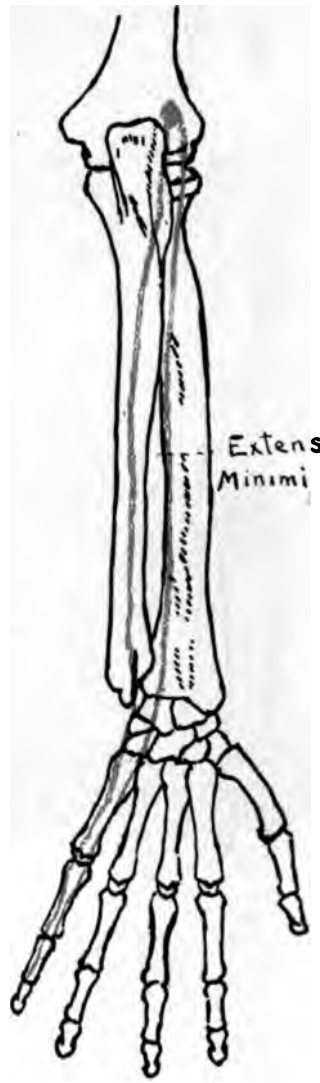


FIG. 134.—Extensor Digiti Quinti Propius (Extensor Minimi Digiti)

from the external condyle of the humerus into the second and third phalanges of the little finger

3—Extensor carpi ulnaris: from the external condyle of the humerus into the base of the fifth metacarpal

4—Anconeus: from the back of the external condyle of the humerus into the olecranon and shaft of the ulna

5—Supinator (supinator brevis): from the external condyle

FIG. 135.—Extensor Carpi Ulnaris

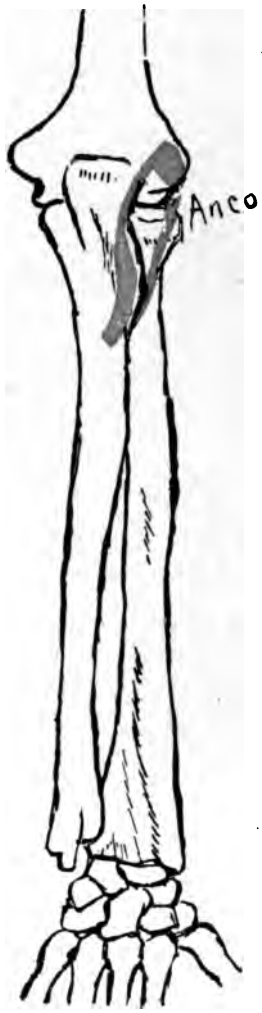


FIG. 136.—Anconeus

into the neck of the radius and the tuberosity of the radius (bicipital tuberosity)

6—Extensor pollicis brevis: from the posterior shaft of the radius into the base of the first phalanx of the thumb

7—Extensor pollicis longus: from the back of the ulna into the base of the last phalanx of the thumb

8—Extensor indicis proprius: from the back of the ulna into the second and third phalanges of the index finger

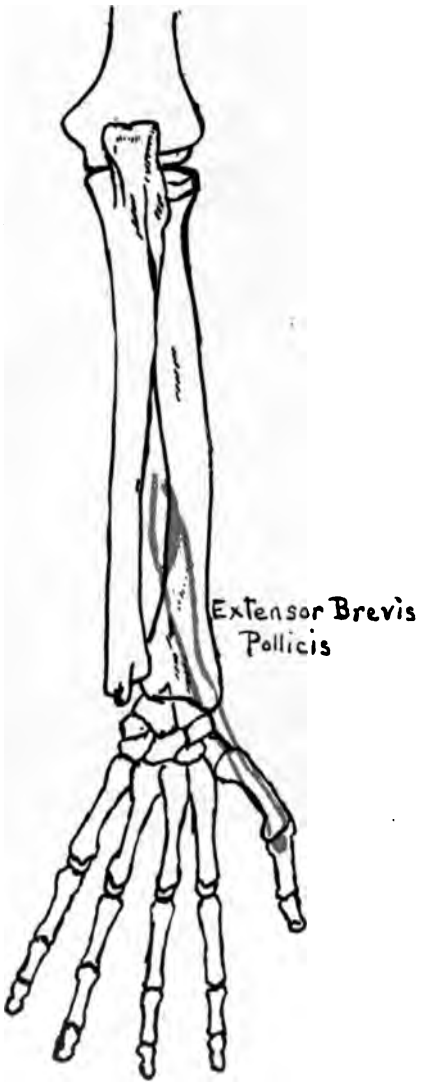


Fig. 137.—Extensor Brevis Pollicis

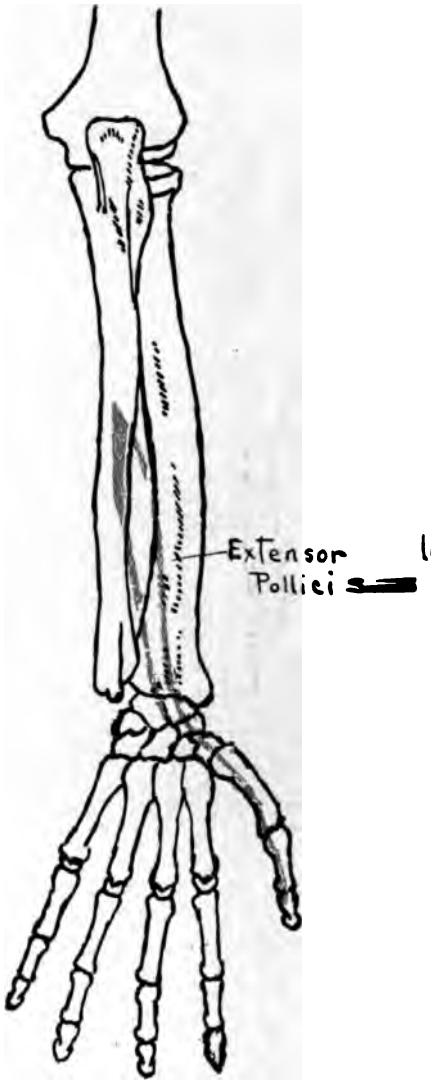


Fig. 138.—Extensor Longus Pollicis

MUSCLES OF THE LOWER EXTREMITY

GLUTEAL REGION

I—Gluteus maximus

Origin

A—From the dorsum of the ilium behind the superior curve line

B—From the sides of the sacrum and coccyx

C—From a tendinous expansion over the sacrum

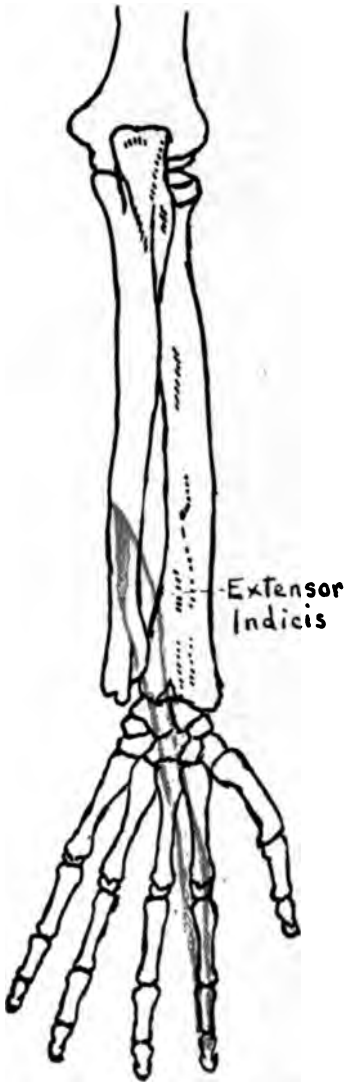


FIG. 139.—Extensor Indicis Proprius

D—From the posterior surface of the sacrotuberous ligament (Great sacrosciatic)

Insertion

A—Into the fascia lata, covering the outer side of the thigh

B—Into a line running from the great trochanter of the femur to the linea aspera

Nervous supply

Inferior gluteal nerve

II—Gluteus medius

Origin

A—From the dorsum of the ilium between the superior and middle curved lines

B—From the outer lip of a portion of the crest of the ilium

Insertion

Into an oblique line, on the outer surface of the great trochanter of the femur

Nervous supply

Superior gluteal nerve

III—Gluteus minimus

Origin

A—From between the middle and the inferior curved lines on the dorsum of the ilium

Insertion

Into the anterior border of the great trochanter of the femur

Nervous supply

The superior gluteal nerve

IV—Pyriformis

Origin

A—From the anterior surface of the sacrum between the anterior sacral foramina

Insertion

Into the posterior part of the upper border of the great trochanter of the femur

Nervous supply

Anterior rami of the first and second sacral

V—Gemellus superior

Origin

A—From the outer surface of the spine of the ischium

Insertion

Into the great trochanter of the femur by a common tendon with the obturator internus and the gemellus inferior muscles

Nervous supply

Anterior rami of the first and second sacral

VI—Obturatori internus

Origin

From the inner two-thirds of the inner surface of the obturator membrane

From the circumference of the obturator foramen

Insertion

Into the trochanteric fossa (digital fossa) of the femur

Nervous supply

Obturator nerve

VII—Gemellus inferior

Origin

From the upper part of the outer lip of the tuberosity of the ischium

Insertion

In common with the tendon of the obturator internus muscle into the great trochanter of the femur

Nervous supply

Anterior rami (muscular branch) of the sacral plexus

VIII—Quadratus femoris

Origin

From the outer border of the tuberosity of the ischium

Insertion

Into the upper part of the linea quadratii on the posterior aspect of the great trochanter of the femur

Nervous supply

Special nerve (muscular branch) from the sacral plexus

FEMORAL REGION

Anterior

1—Tensor fascia lata (Tensor vagina femoris)

Origin

a—From the anterior superior spine of the ilium

b—From the anterior portion of the outer lip of the crest of the ilium

Insertion

Into the fascia lata on the outer aspect of the thigh.

Nervous supply

Superior gluteal nerve

2—Sartorius

Origin

a—From the anterior superior spine of the ilium

b—From the upper half of the notch below

Insertion

Into the upper part of the inner surface of the shaft of the tibia covering the tendons of the gracilis and the semitendinosis

Nervous supply

Femoral nerve (anterior crural)

FIG. 140.—Tensor Fasciae Latae

3—Rectus femoris

Origin

Straight head

From the anterior inferior spine of the ilium

Reflected head

From a groove above the brim of the acetabulum

Insertion

Into the upper border of the patella

Nervous supply

Femoral (anterial crural)

4—Vastus lateralis (vastus externus)

Origin

a—From the anterior border of the ridge upon the great trochanter of the femur

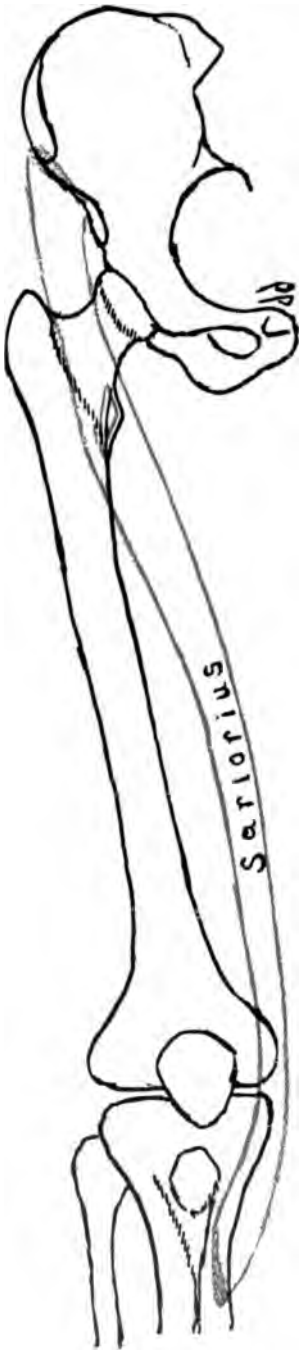


FIG. 141.—Sartorius

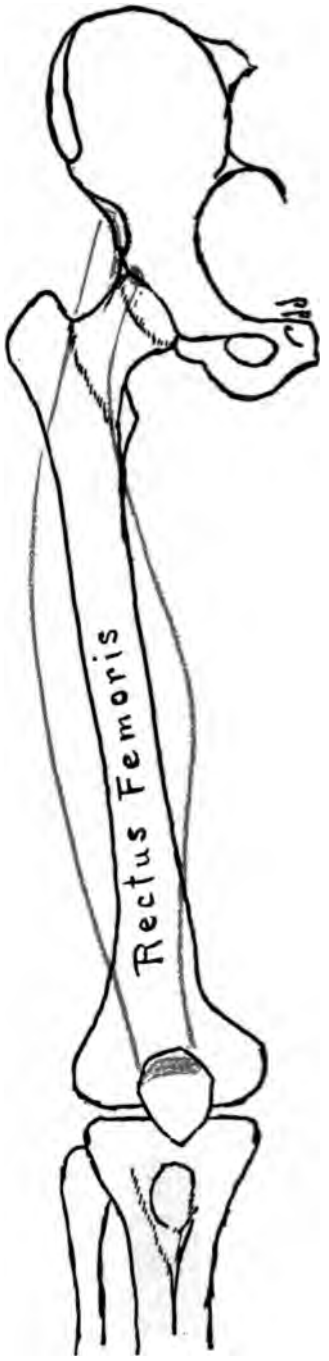


FIG. 142.—Rectus Femoris

b—From a rough line extending from the great trochanter to the linea aspera
c—From a line from the linea aspera to the lateral condyle
d—From the whole length of the outer lip of the linea aspera

Insertion
Into the outer border of the patella

Nervous supply
Femoral nerve (anterior crural)

5—Vastus medialis (vastus internus)

Origin
a—From a line running from the inner side of the neck of the femur to the linea aspera
b—From the whole length of the linea aspera (inner lip)
c—From a line from the linea aspera to the medial condyle
d—From the inner surface of the femur
e—From the inner muscular septum

Insertion
Into the common patellar tendon

Nervous supply
Femoral nerve (anterior crural)

Posterior region

1—Biceps femoris (biceps flexor cruris)

Origin
Long head
In common with the tendon of the semitendinosus from the posterior part of the tuberosity of the ischium
Short head
From the whole length of the outer lip of the linea aspera between the adductor magnus and the vastus lateralis muscles

Insertion
Into the outer side of the head of the fibula, where the tendon divides again into two parts for further insertion into the lateral condyle (outer tuberosity) of the tibia and the fascia of the leg

Nervous supply
Nerve to the hamstrings branch of the ischial (great sciatic)

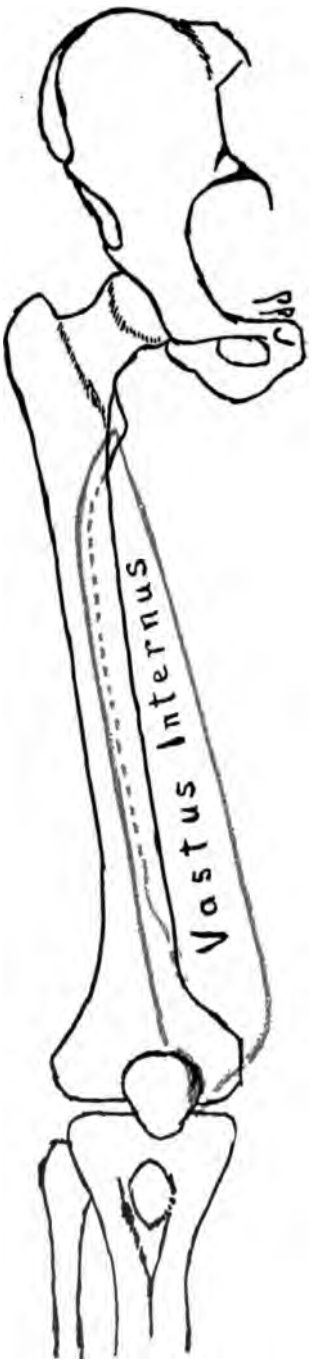


FIG. 143.—Vastus Internus

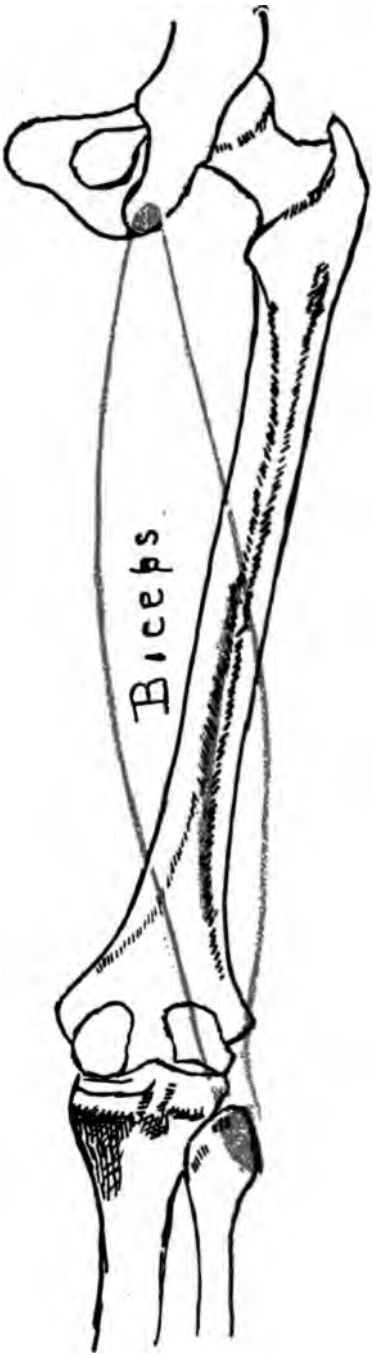


FIG. 144.—Biceps Flexor Cruris (Biceps Femoris)

2—Semitendinosus

Origin

In common with the long head of the biceps femoris from the inner and lower part of the posterior surface of the tuberosity of the ischium

Insertion

Into the upper part of the inner surface of the shaft of the tibia beneath the sartorium and below the gracilis muscle

Nervous supply

Nerve to the hamstrings (sciatic)

3—Semimembranosus

Origin

a—From the upper and outer part of the posterior surface of the tuberosity of the ischium

Insertion

a—Into the posterior part of the medial condyle of the tibia

b—Into a grove on the medial condyle of the tibia (this slip passing under the tibial collateral ligament internal lateral ligament of the knee)

c—Into the posterior and outer part of the condyle of the femur, thus strengthening the posterior ligament of the knee-joint

Nervous supply

Nerve to the hamstrings (sciatic)

Internal region

1—Gracilis

Origin

a—From the inner margin of the rami of the pubis and the ischium

b—From the body of the pubis (lower half)

Insertion

a—Into the upper part of the inner surface of the shaft of the tibia above the point of insertion of the semitendinosus muscle

Nervous supply

Obturator nerve

2—Adductor longus

Origin

From the anterior surface of the pubis close to its angle and below its crest

Insertion

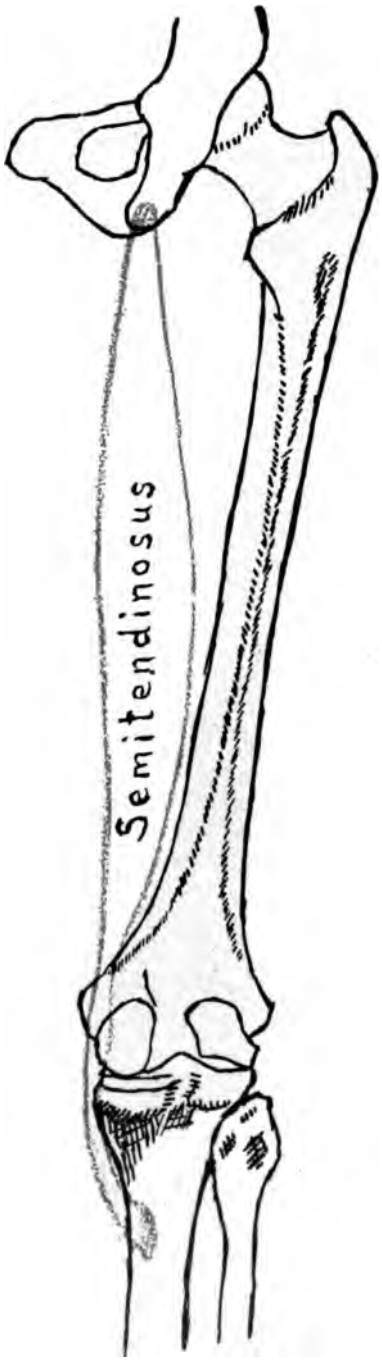


FIG. 145.—Semitendinosus

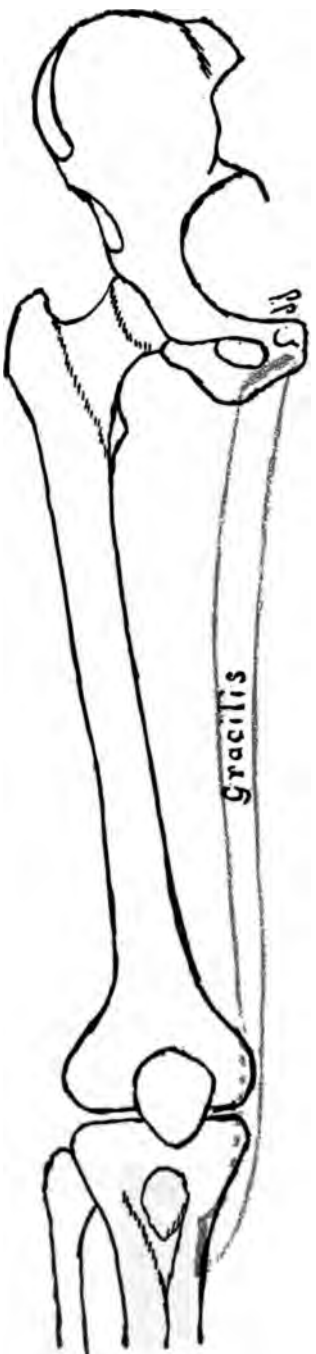


FIG. 146.—Gracilis

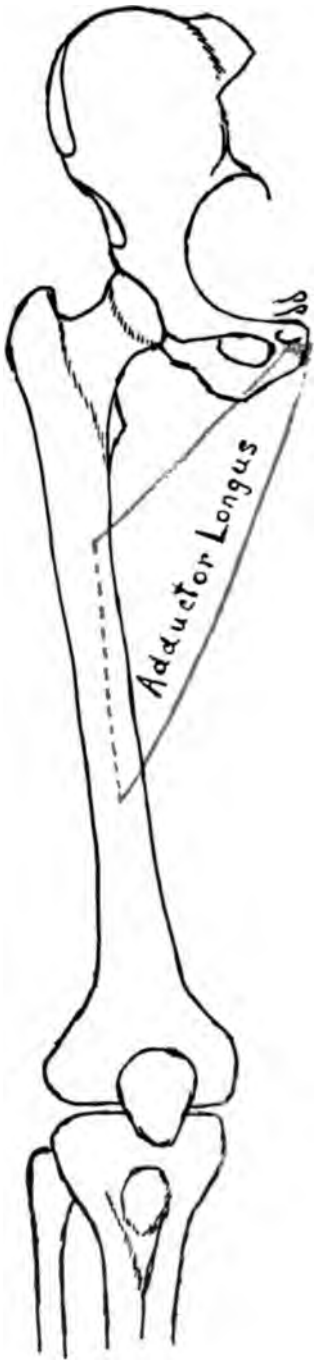


FIG. 147.—Adductor Longus

FIG. 148.—Pectineus

Into the middle third of the inner lip of the linea aspera

Nervous supply

Obturator nerve

3—Pectineus

Origin

From the iliopectineal line and the surface of the bone in front of it, extending from the pectineal eminence to the spine of the pubis

Insertion

Into the femur behind the lesser trochanter

Nervous supply

The obturator nerve and the femoral (anterior crural) and the accessory obturator nerves

4—Adductor brevis

Origin

From the anterior surface of the body and the ramus of the pubis

Insertion

Into the upper part of the linea aspera

Nerve supply

The obturator or femoral nerves (anterior crural)

5—Adductor magnus

Origin

a—From the descending ramus of the pubis (lower part)

b—From the ascending ramus of the ischium

c—From the outer side of the tuberosity of the ischium

Insertion

a—Into the whole length of the linea aspera

Nervous supply

a—Obturator nerve

TIBIOFIBULAR REGION

Anterior tibiofibular

1—Tibialis anterior (tibialis anticus)

Origin

a—From the lateral condyle (outer tuberosity) of the tibia

b—From the upper two-thirds of the outer surface of the shaft of the tibia

Insertion

a—Into the inner and under surface of the first cuneiform bone

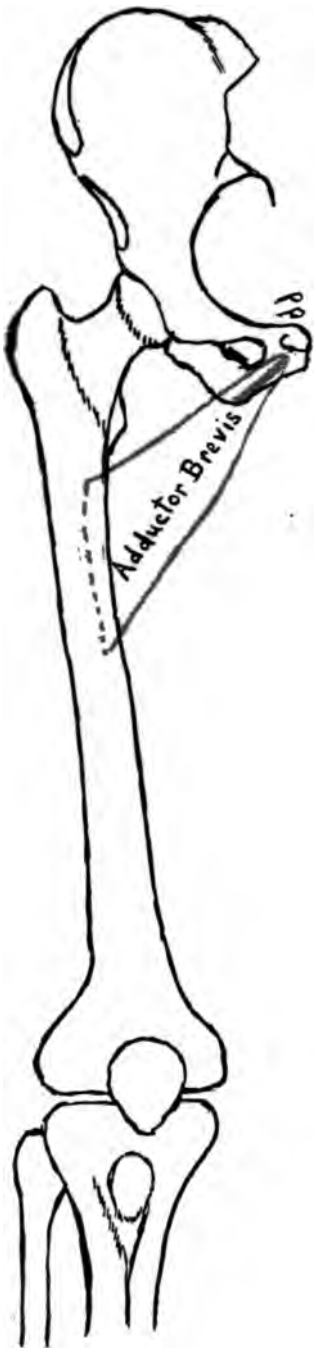


FIG. 149.—Adductor Brevis

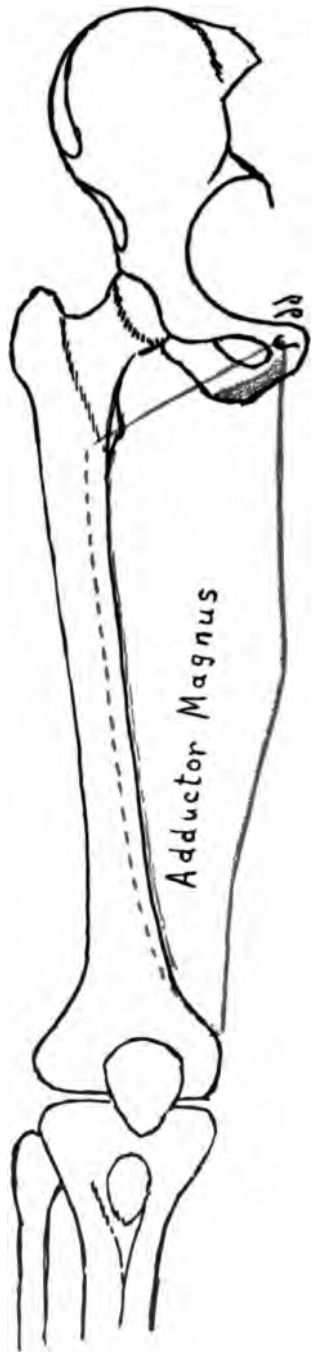


FIG. 150.—Adductor Magnus

FIG. 151.—Tibialis Anticus

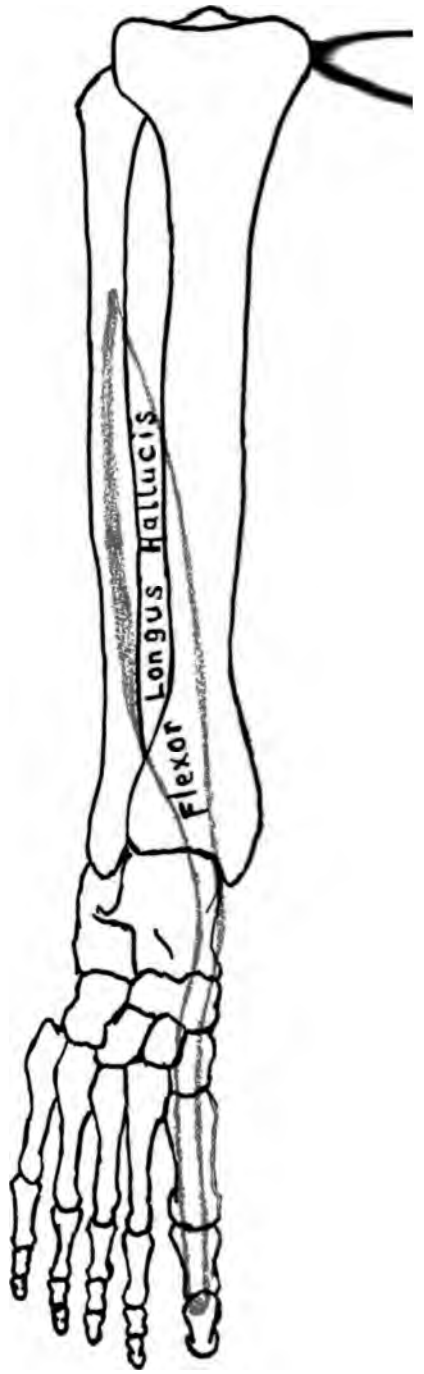


FIG. 152.—Flexor Longus Hallucis

FIG. 153.—Extensor Longus Digitorum

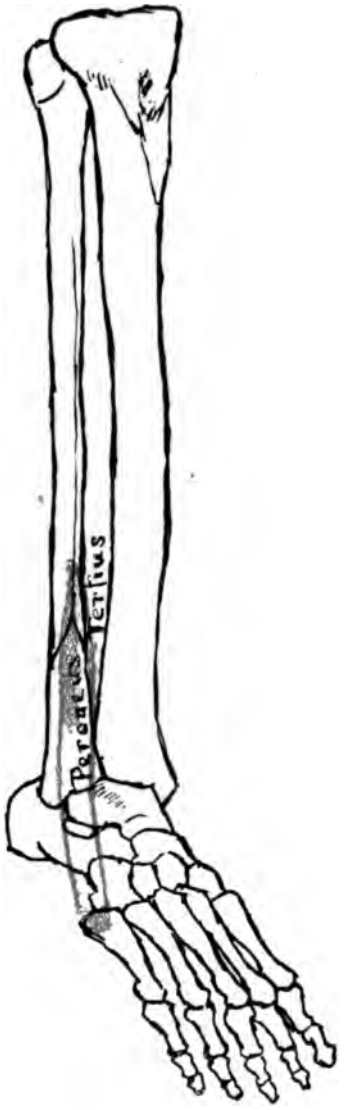


FIG. 154.—Peroneus Tertius

b—Into the base of the first metatarsal bone

Nervous supply

Deep peroneal (anterior tibial) nerve

2—Extensor hallucis longus

Origin

a—From the middle of the anterior surface of the shaft of the fibula

Insertion
Into the base of the last phalanx of the great toe
Nervous supply
Deep peroneal (anterior tibial)

3—Extensor digitorum longus
Origin
a—From the condyle of the tibia
b—From the upper three-fourths of the anterior surface of the fibula
Insertion
Into the base of the second and third phalanges of the four outer toes
Nervous supply
Deep peroneal (anterial tibial)

4—Peroneus tertius
Origin
a—From the lower one-fourth of the anterior surface of the shaft of the fibula
2—From the lower part of the interosseus membrane
Insertion
Into the base of the fifth metatarsal bone
Nervous supply
Deep peroneal (anterior tibial) nerve

Fibular region

1—Peroneus brevis
Origin
a—From the lower two-thirds of the outer surface of shaft of the fibula
Insertion
Into the base of the fifth metatarsal bone
Nervous supply
Superficial peroneal (musculocutaneous branch of the externus popliteal nerve)

2—Peroneus longus
Origin
a—From the head and the upper two-thirds of the outer surface of the fibula
Insertion
Into the outer side of the base of the first metatarsal bone
Nervous supply
Superficial peroneal (musculocutaneous branch of the external popliteal)

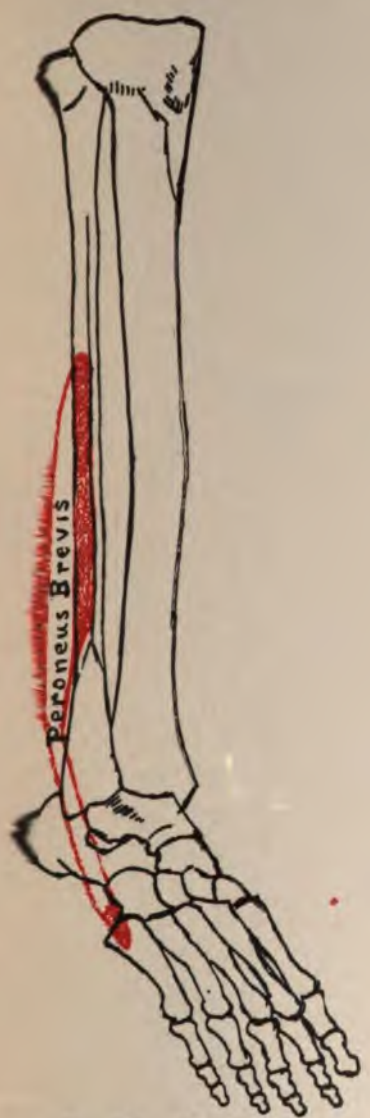


FIG. 155.—Peroneus Brevis

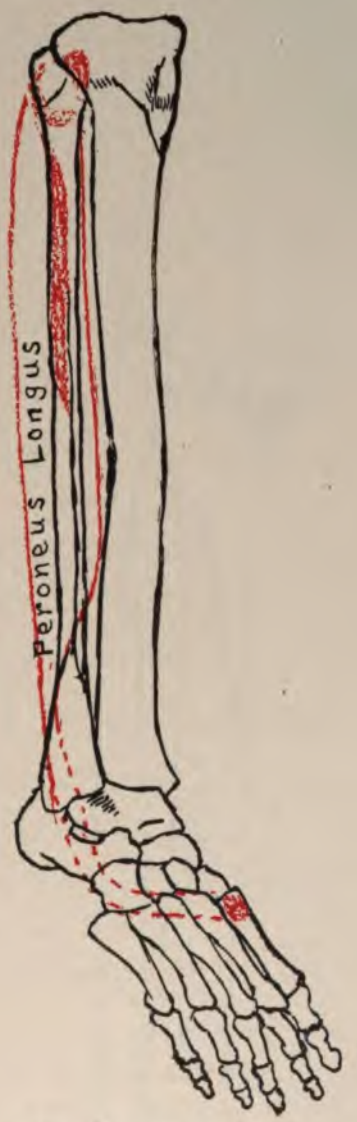


FIG. 156.—Peroneus Longus

Posterior tibio-fibular

1—Gastrocnemius

Origin

Inner head

1—From a depression at the upper and posterior part of the inner condyle of the femur

2—Internal division of the linea aspera

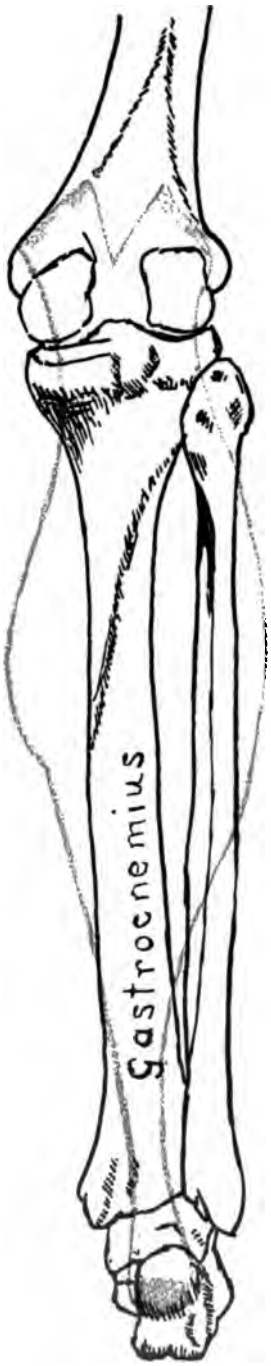


FIG. 157.—Gastrocnemius

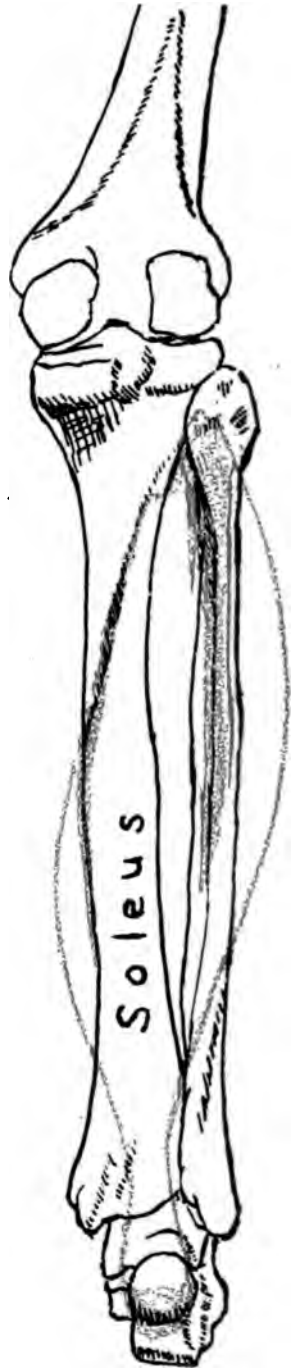


FIG. 158.—Soleus

Outer head

From a depression in the posterior surface of the lateral condyle of the femur

Insertion

In common with the tendon of the soleus into the lower part of the posterior surface of the os calcaneus

Nervous supply

Tibial nerve (internal popliteal)

2—Plantaris

Origin

a—From the outer division of the linea aspera

b—From the oblique ligament (posterior) of the knee joint

Insertion

Into the inner border of the tendo-calcaneus (Achilles)

Nervous supply

Tibial nerve (internal popliteal)

3—Soleus

Origin

a—From the head and the upper third of the posterior surface of the fibula

b—From the middle third of the internal border of the tibia

c—From an oblique line on the posterior surface of the tibia

Insertion

In common with the tendon of the gastrocnemius thus forming the tendo-calcaneus (Achilles)

Nervous supply

Tibial nerve (internal popliteal)

4—Popliteus

Origin

From a groove on the outer side of the internal condyle of the femur situated below the tubercle for the attachment of the posterior ligament of the knee-joint

Insertion

Into a triangular surface on the posterior aspect of the upper portion of the tibia above its oblique line

Nervous supply

This muscle is supplied with motor power through the tibial (internal popliteal) nerve (a branch of the sciatic)

5—Tibialis posterior

FIG. 159.—Popliteus

FIG. 160.—Tibialis Posticus

Origin
a—From the posterior surface of the shaft of the tibia
b—From the greater part of the posterior surface of the interosseous membrane
c—From the upper three-fourths of the shaft of the fibula
Insertion
a—Into the tuberosity of the navicular (scaphoid) bone
b—Into the first and second cuneiform bones
Nervous supply
Tibial (posterior tibial)

6—Flexor hallucis longus
Origin
a—From the lower two-thirds of the posterior surface of the shaft of the fibula
b—From the lower part of the interosseous membrane
Insertion
Into the base of the last phalanx of the great toe
Nervous supply
Tibial nerve (posterior tibial)

7—Flexor digitorum longus
Origin
From the posterior surface of the shaft of the tibia below the oblique line
Insertion
Into the bases of the last phalanges of the four lesser toes
Nervous supply
Tibial nerve (posterior tibial)

FIG. 161.—Flexor Longus Digitorum

GLOSSARY

MUSCLES

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
MUSCLES OF THE BACK	
Superficial	
Levator scapulae	Levator anguli scapulae
MUSCLES OF THE CHEST	
Serratus anterior	Serratus magnus
MUSCLES OF THE UPPER EXTREMITY	
Biceps brachii	Biceps
Lacertus fibrosus	Bicipital fascia
Brachialis	Brachialis anticus
Triceps brachii	Triceps
Caput mediale	Inner head
Caput laterale	Outer head
Pronator teres	Pronator radii teres
Caput ulnare	Coronoid head
Brachio-radialis	Supinator longus
Supinator	Supinator brevis
Extensor carpi radialis longus	Extensor carpi radialis long
Extensor carpi radialis brevis	Extensor carpi radialis brev
Extensor indicis proprius	Extensor indicis
Extensor digiti quinti proprius	Extensor minimi digiti
Abductor pollicis longus	Extensor ossis metacarpi licis
Abductor pollicis brevis	Abductor pollicis
Extensor pollicis brevis	Extensor primi internodii licis
Extensor pollicis longus	Extensor secundi interm pollicis
Lig. carpi transversum	Anterior annular ligament
Lig. carpi dorsale	Posterior annular ligamen
MUSCLES OF LOWER EXTREMITY	
Tensor fasciae latae	Tensor fasciae femoris
Canalis adductorius (Hunteri)	Hunter's canal
Trigonum femorale (fos-	

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
sa Scarpae major)	Scarpa's triangle
Canalis femoralis	Crural canal
Annulus femoralis	Crural ring
M. quadriceps femoris	Quadriceps
Rectus femoris	Rectus femoris
Vastus lateralis	Vastus externus
Vastus intermedius	Crureus
Vastus medialis	Vastus internus
M. articularis genu	Subcrureus
Tibialis anterior	Tibialis anticus
Tendo calcaneus	Tendo Achillis
Tibialis posterior	Tibialis posticus
Quadratus plantae	Accessorius
Lig. transversum cruris	Upper anterior annular ligament
Lig. laciniatum	Internal annular ligament
Retinaculum musculorum peronaeorum superius	External annular ligament
Retinaculum musculorum peronaeorum inferius	External annular ligament

AXIAL MUSCLES

MUSCLES OF THE BACK	
Serratus posterior superior	Serratus posticus superior
Serratus posterior inferior	Serratus posticus inferior
Splenius cervicis	Splenius colli
Sacro-spinalis	Erector spinae
ILIO-COSTALIS	
Lumborum	Sacro-lumbalis
Dorsi	Accessorius
Cervicis	Cervicalis ascendens
LONGISSIMUS	
Dorsi	Dorsi
Cervicis	Transversalis cervicis
Capitis	Trachelo-mastoid
SPINALIS	
Dorsi	Dorsi
Cervicis	Colli

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Capitis	Capitis
SEMISPINALIS	
Dorsi	Dorsi
Cervicis	Colli
Capitis	Complexus
Multifidus	Multifidus spinae
MUSCLES OF HEAD AND NECK	
Epicranius	Occipito-frontalis
Galea aponeurotica	Epicranial aponeurosis
Procerus	Pyramidalis nasi
Pars transversa (nasalis)	Compressor naris
Pars alaris (nasalis)	Dilatores naris
Auricularis anterior	Attrahens aurem
Auricularis posterior	Retrahens aurem
Auricularis superior	Attolens aurem
Orbicularis oculi	Orbicularis palpebrarum
Pars lacrimalis	Tensor tarsi
Triangularis	Depressor anguli oris
Quadratus labii superioris	
Caput zygomaticum	Zygomaticus minor
Caput infraorbitale	Levator labii superioris
Caput angulare	Levator labii superioris alaeque nasi
Zygomaticus	Zygomaticus major
Caninus	Levator anguli oris
Quadratus labii inferioris	Depressor labii inferioris
Mentalis	Levator menti
Platysma	Platysma myoides
Sterno-thyreoid	Sterno-thyroid
Thyreo-hyoid	Thyro-hyoid
MUSCLES AND FASCIA OF THE ORBIT	
Fascia bulbi	Capsule of Tenon
Septum orbitale	Palpebral ligaments
Rectus lateralis	Rectus externus
Rectus medialis	Rectus internus
MUSCLES OF THE TONGUE	
Genio-glossus	Genio-hyo-glossus
Longitudinalis superior	Superior lingualis
Longitudinalis inferior	Inferior lingualis
Transversus linguae	Transverse fibers
Verticalis linguae	Vertical fibers
MUSCLES OF THE PHARYNX	
Pharyngo-palatinus	Palato-pharyngeus

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
M. uvulae	Azygos uvulae
Levator veli palatini	Levator palati
Tensor veli palatini	Tensor palati
Glosso-palatinus	Palato-glossus
DEEP LATERAL MUSCLES OF NECK	
Scalenus anterior	Scalenus anticus
Scalenus posterior	Scalenus posticus
Longus capitis	Rectus capitis anticus major
Rectus capitis anterior	Rectus capitis anticus minor
MUSCLES OF THORAX	
Transversus thoracis	Triangularis sterni
Diaphragma, pars lumbalis	Diaphragm, lumbar part
Crus mediale Crus intermedium Crus laterale	Crus and origin from internal arcuate ligaments
Arcus lumbocostalis medialis (Halleri)	Ligamentum arcuatum internum
Arcus lumbocostalis lateralis (Halleri)	Ligamentum arcuatum externum
MUSCLES OF ABDOMEN	
Ligamentum inguinale (Pouparti)	Poupart's ligament
Ligamentum lacunare (Gimbernati)	Gimbernat's ligament
Fibrae intercrurales	Intercolumnar fibers
Ligamentum inguinale reflexum (Collesi)	Triangular fascia
Annulus inguinalis subcutaneus	External abdominal ring
Crus superius	Internal pillar
Crus inferius	External pillar
Falx (aponeurotica) inguinalis	Conjoined tendon
M. transversus abdominis	Transversalis muscle
Linea semicircularis (Douglasi-)	Fold of Douglas
Annulus inguinalis abdominalis	Internal abdominal ring
PERINEUM AND PELVIS	
Transversus perinei superficialis	Transversus perinei
M. sphincter urethrae membranaceae	Compressor urethrae

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Diaphragma urogenitale	Deep transverse muscle and compressor urethrae
Fascia diaphragmatis urogenitalis superior	Deep layer of triangular ligament
Fascia diaphragmatic urogenitalis inferior	Superficial layer of the triangular ligament
Arcus tendineus fasciae pelvis	White line of pelvis
Ligamenta pubo-prostatica	Anterior and lateral true ligaments of bladder
Fascia diaphragmatis pelvis superior	Visceral layer of pelvic fascia
Fascia diaphragmatis pelvis inferior	Anal fascia

CARDIOVASCULAR SYSTEM

PERICARDIUM

Membranous sac surrounding the heart and great vessels

Two layers

Outer, fibrous; continuation of deep cervical fascia. Inner, serous or visceral

HEART

I—Hollow muscular organ

Weight from 10 to 12 ounces

Length, five inches; width, three inches; thickness, three inches

II—Shows for examination

1—Right atrium or auricle

Openings

a—Superior vena cava

b—Inferior vena cava

c—Coronary sinus

d—Valvula sinus coronarii (Foramina Thebesii)

e—Auriculo-ventricular, guarded by the tricuspid valve

Musculi pectinati

Muscular columns in the auricle

2—Left auricle

Openings

a—Four pulmonary veins

b—Left auriculo-ventricular guarded by mitral valve

3—Right ventricle

Openings

a—Tricuspid opening into the right auricle guarded by the tricuspid valve

b—Pulmonic opening into the pulmonary artery guarded by the pulmonic valve

Muscles

a—Trabeculae carneae (columnae carneae) muscular elevations in the ventricle

b—Chordae tendineae extend from the trabeculae carneae to the valve

4—Left ventricle

Openings

a—Mitral into the left auricle guarded by the mitral valve

b—Aortic into the aorta guarded by the aortic semilunar valve

III—Structures

1—Endocardium

Inner coat, a single layer of endothelial cells on a basement membrane; reduplication forms the valves

2—Myocardium

Quadrilateral muscle fibers connected by branches. Striated involuntary

3—Epicardium

Visceral layer of the pericardium

IV—Nerve supply

Vagus-inhibitory and sympathetic accelerator

V—Blood supply

Coronary arteries

VI—Topography

1—Heart on the chest wall

Mark a point one-half inch to the right and one inch to left of the sternum at level of third costal cartilage. Mark a point on the right side at the junction of the seventh costal cartilage with the sternum. Mark another point at the apex and unite all the points to outline the heart

B—Apex

Is in the left fifth intercostal space, about three and one-quarter inches from the median line.

C—Base

Is on a line drawn from the second left interspace about two inches from the median line, to the upper

border of the third right intercostal cartilage, about one and one-quarter inches from the median line

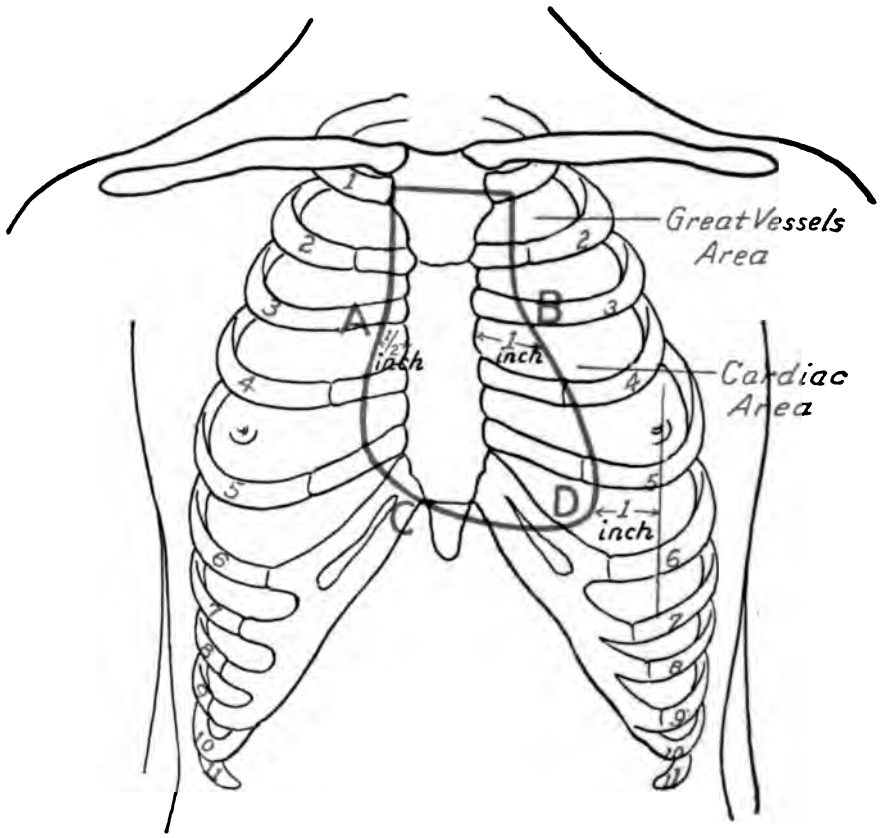


Fig. 162.—Heart on the Chest Wall

D—Valves

a—Pulmonic at junction of the left third costal cartilage and the sternum

b—Aortic in center of sternum at third costal cartilage

c—Mitral in center of sternum at fourth costal cartilage

d—Tricuspid in center of sternum between the fourth and fifth cartilages

VIII—Adult circulation

The venous blood is collected into the right auricle, goes thence to the right ventricle, to the pulmonary artery, and to the lungs; after oxygenation, is carried by the pulmonary veins to the left

auricle, to the left ventricle, into the circulation and by the vena cava back to the right auricle

The valves of the heart

Right auricle

A—Eustachian

Situated between the anterior margin of the inferior vena cava and the auriculo-ventricular orifice; in the fetus it directs the blood from the inferior vena cava through the foramen ovale into the left auricle

B—Coronary valve

Prevents regurgitation of blood into the coronary sinus

Right ventricle

A—Tricuspid

Consists of three cusps, the bases of which are attached to a ring around the auriculo-ventricular opening; the edges are free in the ventricle and attached to the chorda tendinae. The tricuspid valve prevents the regurgitation of blood from the right ventricle into the right auricle during ventricular systole

B—Pulmonic semilunar

Guards the pulmonic orifice, and is composed of three segments, attached at their bases to the wall of the pulmonary artery at their free edges show a nodular projection the corpus aurantii

Left ventricle

A—Mitral acts like the tricuspid valve, composed of two cusps

B—Aortic valve, guards the aortic opening

IX—Fetal circulation

Arterial blood from the placenta by way of the umbilical vein passes to the under surface of the liver where it breaks up into two streams; one goes directly into the vena cava by the ductus venosis, the remainder after flowing through the liver reaches the vena cava by the hepatic veins. The inferior vena cava empties into the right auricle, and through the foramen ovale its contents pass into the left auricle, then into the left ventricle and into circulation. That blood collected by the superior vena cava enters the right auricle, crosses the stream from below, passes into the right ventricle; it should then go to the lung; but the lung being collapsed, most of it passes through the ductus arterosis to the arch of the aorta and thence into circulation. The blood is carried back to the placenta by the hypogastric arteries.

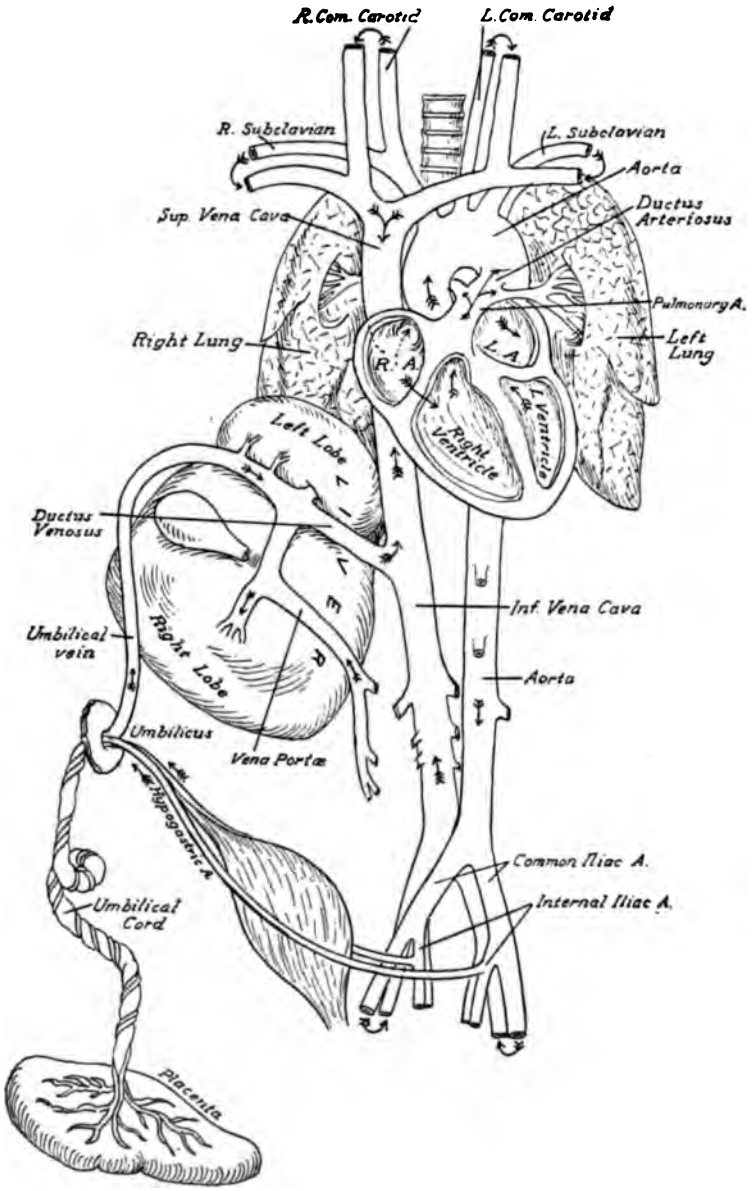


FIG. 163.—Plan of Fetal Circulation

ARTERIAL SYSTEM

DEFINITION

Arteries are vessels that carry arterial blood from the heart to the tissues for nutrition. They are recognized by:

1—Their pulsations
2—Their swelling proximally when compressed distally
3—Their firm, round, resisting, elastic, cord-like feeling
4—The peculiar sensation felt when they are compressed between the fingers; presenting a central depression and two lateral elevated ridges
5—Their walls (thicker than those of the veins)
6—Their rubber tube-like feeling when touched and tendency to slide from beneath the fingers
7—The force required to compress them
8—Their regular outline
9—Their pinkish or pinkish-yellow color

I—Arch of the aorta
1—Origin
Opening of the left ventricle
2—Terminates
At the lower border of the fourth dorsal vertebra
3—Branches
A—Right coronary
B—Left coronary
C—Innominate from one to two inches long, divides into
a—Right subclavian
b—Right common carotid
D—Left common carotid
E—Left subclavian

II—Thoracic aorta
1—Origin
Lower border of the fourth dorsal vertebra
2—Termination
Lower border of the twelfth dorsal vertebra
3—Branches
A—Pericardiac branches distributed to the pericardium
B—Bronchial arteries: three nutrient vessels to the lungs
C—Esophageal: four or five in number to supply the esophagus
D—Posterior mediastinal (several): to glands, etc., in the mediastinum
E—Intercostals: eighteen (nine on each side)
a—Posterior dorsal to the muscles of back
b—Spinal to the spinal cord and its membranes
c—Collateral intercostal along the upper border of the rib below

III—Abdominal aorta
1—Origin

From the lower border of the twelfth dorsal vertebra

2—Termination

Lower border of the fourth lumbar vertebra

3—Branches

A—Phrenic

Internal, to front of the thorax and diaphragm

External to the side of the thorax.

B—Coeliac axis

a—Gastric

To cardiac orifice of the stomach, along the lesser curvature to the pylorus, where it anastomoses with the pyloric branch of the hepatic artery

b—Hepatic

1—Pyloric to pyloric end of lesser curvature

2—Gastroduodenalis

A—Gastro-epiploica dextra to the pyloric end of the greater curvature of the stomach

B—Pancreatic-duodenalis superior

3—Cystic to the gall bladder

4—Right hepatic to the right lobe of the liver

5—Left hepatic to the left lobe of the liver

c—Splenic

1—Pancreatico-parvus to the pancreas

2—Pancreatico-magnus to the pancreas

3—Gastrica brevia (five to seven) to the greater curvature of stomach from left to right

4—Terminal branches enter the hilum of spleen

5—Gastro-epiploica sinestra to cardiac end of greater curvature, anastomosing with gastro-epiploica dextra

C—Superior mesenteric

a—Inferior pancreatico-duodenal to pancreas and duodenum

b—Vasa intestinae tenuis (twelve to fifteen): form arches in the mesentery to supply the small intestine

c—Ilio-colic, to ilium and colon

d—Colica dextra to ascending colon

e—Colica media to transverse colon

D—Suprarenal

To suprarenal capsule

E—Renal

Branches to the substance of the kidney, to the capsule and to the ureter

F—Spermatic (or ovarian)

To testes or ovaries and to the uterus

G—Inferior mesenteric

a—Colica sinestra

To the descending colon

b—Sigmoidal

To the sigmoidal flexure

c—Superior hemorrhoidal

To the rectum

H—Lumbar

Five pairs; they supply the abdomen and the meninges of the cord

I—Sacro-media

Supply the coccyx

4—Common iliac

A—Origin

From the bifurcation of the abdominal aorta at the fourth lumbar vertebra

B—Termination

Sacro-iliac synchondrosis: gives off no branches but divides into internal and external iliac

5—Internal iliac

A—Origin

Sacro-iliac synchondrosis at the bifurcation of the common iliac

B—Termination

Sacro-sciatic notch; dividing into an anterior and a posterior trunk

C—Branches

a—Anterior trunk

1—Superior vesicle to the side and top of the bladder

2—Middle vesicle to the middle of the bladder

3—Inferior vesicle to the base of the bladder

4—Middle hemorrhoidal to the rectum and vagina

5—Uterine, to uterus

6—Vaginal, same as inferior vesicle in the male

7—Obturator, passes to sacro-sciatic notch; supplies pelvis muscles and bones

8—Internal pudic passes out of the pelvis through the great sacro-sciatic foramen; reënters the pelvis through the lesser sacro-sciatic foramen;

supplies the hip joint and muscles of the thigh

b—Posterior trunk

1—Lateral sacral to the sacrum

2—Ilio-lumbar supplies the ilium and the lumbar vertebrae

3—Gluteal: largest branch of internal iliac; supplies the gluteal muscle and hip joint

6—External iliac

A—Origin

Sacro-iliac synchondrosis at the bifurcation of the common iliac

B—Termination

Lower border of the inguinal (Poupart's) ligament

C—Branches

a—Deep epigastric

To the abdominal muscle and skin

b—Deep circumflex iliac

To the iliac muscle

7—Femoral artery

A—Origin

Lower border of the inguinal (Poupart's) ligament

B—Termination

Adductor canal (Hunter's) opening in the adductor magnus muscle

C—Description

The thigh abducted and rotated outward; a line drawn from a point midway between the anterior superior spine of the ilium and the symphysis pubic, to the most prominent part of the internal condyle in the upper two-thirds, will give the course of the femoral artery

D—Branches

a—Superficial epigastric, in the superficial fascia to the umbilicus

b—Superficial circumflex iliac, to the iliac crest

c—Superficial external pudic, to the skin of the penis and scrotum

d—Deep external pudic to the skin of the perineum

e—Profunda femoris

1—External circumflex

Ascending branches to the outer side of the hip

Transverse to back of hip

Descending as far as the knee
2—Medial femoral circumflex (internal circumflex)
Ascending to adductors
Descending to adductors
Articular to head of femur
3—Perforating
Superior, pierces the adductor magnus
Middle, nutrient to the femur
Inferior, pierces the adductor magnus
f—Muscular: (two to five) to the sartorius and the vastus medialis
g—Anastomotica magna
Superficial branch to integument
Deep branch to inner side of knee-joint

8—Popliteal
A—Origin
Lower opening in adductor magnus
B—Termination
Lower border of the popliteus muscle
C—Branches
a—Muscular to the flexor muscles: gastrocnemius and plantaris
b—Cutaneous branches to integument of calf
c—Superior internal articular to vastus medialis and joint
d—Superior genu lateralis (superior external articular) to vastus lateralis and joint
e—Azygos articular to synovial membrane of joint
f—Genu inferior medialis (inferior internal articular) to head of tibia and joint
g—Inferior genu lateralis to front of knee-joint

9—Anterior tibial
A—Origin
Bifurcation of popliteal at lower border of popliteus muscle
B—Termination
Bend of ankle where it becomes the dorsalis pedis
C—Branches
a—Posterior recurrent tibial to popliteus muscle
b—Superior fibular to the soleus and peroneus longus
c—Anterior recurrent tibial to the knee-joint
d—Muscular branches to the muscles of the leg
e—Internal malleolar

f—External malleolar to outer ankle
g—Dorsalis pedis
Tarsal to tarsal joints
Metatarsal
Three interossei
Seven digital branches
Dorsalis hallucis
Branches to great toe
Branches to inner side of second toe
Communicating
Anastomosis with external plantar arch

10—Posterior tibial
A—Origin
Lower border of popliteal muscle
B—Termination
To lower edge of tibial collateral (internal lateral) ligament
C—Branches
a—Peroneal, gives blood supply to interosseous membrane, peroneal muscles, calcaneus and fibula
b—Muscular to soleus and deep muscles of the leg
c—Nutrient to the tibia
d—Communicating to similar branch of peroneal
e—Internal calcaneal to heel and sole of the foot
f—Medial plantar
1—Description
Internal bifurcation of the posterior tibial, directed along the inner border of the foot to the base of the first metatarsal bone
2—Branches
A—Digital
B—Cutaneous
C—Muscular
g—External or lateral plantar
1—Description
Placed across the tarsal end of the metatarsus
2—Branches
A—Recurrent to tarsal joint
B—Posterior perforating to outer three interosseous spaces
C—Digital, supplies outer three and one-half toes

ARTERIES OF THE HEAD AND NECK

XI—Common carotid

1—Origin

A—Right common carotid comes from the innominate artery behind right sterno clavicular articulation

B—Left common carotid comes directly from arch of the aorta and is the longer vessel

2—Termination

Upper border of thyroid cartilage

3—Branches

External carotid

Internal carotid

XII—Internal carotid

1—Origin

A—Upper border of thyroid cartilage

2—Termination

Lateral cerebral fissure (fissure of Sylvius); there it terminates into anterior cerebral and middle cerebral

3—Branches

A—Cervical portion

None

B—Petrous portion

a—Tympanic to tympanum

C—Cavernous portion

a—Arteriae receptaculi to pituitary body

b—Meningeal to dura mater

c—Ophthalmic

1—Orbital

A—Lacrimal to gland and lid

B—Supra orbital, largest branch

C—Posterior ethmoidal to dura and nose

D—Anterior ethmoidal

E—Superior palpebral to lid

F—Inferior palpebral to lower lid

G—Frontal to muscles and skin

H—Nasal

2—Ocular

A—Arteria centralis retinea to the retina

B—Muscular

Anterior ciliary to the iris

Superior to ocular muscles

Inferior to ocular muscles

C—Short ciliary six to twelve around optic nerve

D—Long ciliary to iris

d—Cerebral portion

a—Anterior cerebral

To anterior part of the brain

b—Middle cerebral

To brain around lateral fissure (Sylvian)

c—Posterior communicating

To form the circle of Willis

d—Anterior choroid

XIII—External carotid

1—Origin

Upper border of thyroid cartilage at bifurcation of common carotid

2—Termination

Point midway between angle of mandible and mastoid process where it divides into temporal and internal maxillary

3—Branches

Anterior set

a—Superior thyroid

1—Muscular and glandular branches

2—Hyoid, along lower border of os hyoidea

3—Superficial descending, crosses common carotid

4—Crico-thyroid crosses crico-thyroid membrane

b—Lingual

1—Hyoid along upper border of bone

2—Dorsalis linguae to tongue, tonsil and palate

3—Sublingual to gland, mouth, gums

4—Ranine, under surface of tongue to tip

c—Facial

Begins at angle of mandible, crosses face obliquely and at inner canthus, becomes angular

A—Inferior (ascending) palatine to soft palate and tonsil

B—Tonsillar to tonsil and root of tongue

C—Submaxillary, to gland, skin muscles

D—Submental

E—Muscular, to pterygoid, masseter, buccinator

F—Inferior labial to lower lip

G—Inferior coronary to lower lip

H—Superior coronary to upper lip

I—Lateralis nasi, to dorsum of nose

J—Angular, termination of facial trunk

Posterior set

a—Occipital

1—Muscular, to digastric and stylohyoid

2—Sterno mastoid to the muscle

3—Auricular to back part of concha

4—Inferior meningeal, to dura mater in posterior fossa

5—Princeps cervicis

Superficial branch anastomosis with cervical of transverse colli

Deep branch anastomoses with vertebral and deep cervical branch of superficial intercostal

b—Posterior auricular

1—Branches to muscles and glands

2—Stylo-mastoid to tympanum and mastoid cells

3—Auricular to cartilages of ear

4—Mastoid to scalp above ear

Ascending set

a—Ascending pharyngeal

1—Pre-vertebral branches to muscles and nerves

2—Tympanic to inner wall of tympanum

3—Meningeal branches to dura mater

4—Pharyngeal branches three or four in number

Terminal set

a—Superficial temporal

1—Transverse facial

2—Anterior auricular branches to pinna

3—Middle temporal, supplies the muscle

4—Anterior temporal to the forehead

5—Posterior temporal along side of head

b—Internal maxillary

1—Maxillary portion

A—Tympanic

To membrana tympani

B—Deep auricular to outer surface of membrana tympani

C—Middle meningeal (large meningeal)

To dura and cranial bones

D—Small meningeal to dura and semilunar (Gasserian) ganglion

E—Inferior alveolar (Inferior Dental)

Lingual to mucous membrane of mouth

Incisor

Mental
Terminal branches
2—Pterygoid portion
Deep temporal to temporal muscle
Pterygoid branches pterygoid muscles
Masseteric, to deep surface of masseter
Buccal, a small branch to buccinator
3—Spheno maxillary portion
Alveolar
Dental to molars and bicuspids
Branches to antrum and gums
Infra orbital
Several branches to the orbit
Anterior dental to front teeth and antrum
Posterior (descending) to palate and glands
Vidian
To eustachian tube and pharynx

ARTERIES OF THE UPPER EXTREMITY

XIV—Subclavian
Origin
Right subclavian arises from the innominate opposite right sterno clavicular articulation
Left arises directly from the arch of the aorta
Termination
Outer border of first rib
Description
Divided into three parts by scalene anterior muscle
1st part
From origin to inner border of scalenus anterior
2nd part
Posterior to scalene anterior
3rd part
From outer border of scalene anterior to outer border of first rib
Branches
A—Vertebral
Lateral spinal
To spinal cord and membranes and bodies of vertebra
Muscular branches to deep cervical muscles
Posterior meningeal to dura mater
Anterior spinal, to spinal cord and membranes

Posterior inferior cerebellar, to cerebellum and choroid plexus
Bulbar to medulla oblongata
Basilar (two vertebrals enter skull through foramen magnum and unite to form the basilar)
Branches
A—Transverse
To Pons varolii and internal auditory canal
B—Anterior, inferior cerebellar
To cerebellum
C—Superior cerebellar
To pia mater, pineal gland
D—Posterior cerebral
Terminal division of basilar

B—Thyroid axis
Inferior thyroid
Inferior laryngeal to posterior muscles of larynx
Tracheal branches to trachea
Esophageal branches
Ascending cervical to muscles and spinal cord
Muscular to muscles of hyoid bone and of the pharynx
Transversalis colli
Superficial cervical beneath trapezius
Posterior scapular, along the posterior border
Supra scapular
Supra-acromial
Supra-sternal to skin of the chest
Muscular to sterno-mastoid
Nutrient to the clavicle

C—Internal mammary
From the under surface of the subclavian behind the clavicle. Passes down between pleura and costal cartilages. At the sixth intercostal space divides into the terminal branches
1—Comes nervi phrenica, between the pleura and pericardium. Supplies the diaphragm
2—Mediastinal, to anterior mediastinum
3—Pericardial, to pericardium
4—Sternal to sternum
5—Anterior intercostal, to upper five or six intercostal spaces. Anastomoses with aortic intercostal

6—Musculo-phrenic, External of the terminal branches. Supplies two lower intercostal spaces and diaphragm

7—Perforating; to pectoral muscle and mammary gland

8—Superior epigastric, internal terminal branch. Terminates in rectus muscle. Communicates with deep epigastric

D—Superior intercostal

Bends over pleural dome to first and second intercostal spaces. Supplies cord and deep spinal muscles

XV—Axillary

1—Origin

Outer border of first rib

2—Termination

Lower border of teres major muscle

3—Description

Divided into three parts by pectoralis minor

1st part

From outer border of first rib to upper border of the pectoralis minor

2nd part

From upper to lower border of pectoralis minor

3rd part

From lower border of the pectoralis minor to lower border of the teres major

4—Branches

1st part

Superior thoracic

To pectoral muscles and wall of thorax

Acromial thoracic

To pectoralis, deltoid and subclavius

2nd part

Alar thoracic

To glands of axilla

Long thoracic

To Serratus pectorals and glands

3rd part

Subscapular

Anterior circumflex

Around the neck of the humerus to deltoid muscle and shoulder joint

Posterior circumflex

To shoulder joint

XVI—Brachial
1—Origin
Lower border of the teres major
2—Termination
One-half inch below the bend of the elbow
3—Branches
A—Profunda brachii (superior profunda) supplies triceps and anconeus
B—Nutrient to humerus
C—Superior ulnar collateral (inferior profunda) to elbow
D—Inferior ulnar collateral (anastomotica magna) to elbow joint
E—Muscular to anterior muscles of humerus

XVII—Ulnar
1—Origin
From bifurcation of brachial one-half inch below the elbow
2—Termination
Superficial palmar arch (U. S. A. Ulnar superficial arch)
3—Branches
A—Anterior ulnar recurrent supplies anterior muscles in front of wrist
B—Posterior ulnar recurrent supplies joint and muscles around it
C—Common interosseus, divides into two. The anterior or volar interosseous to interosseous membrane. Dorsal (posterior) interosseous to interosseous space
D—Muscular, muscles on ulnar side of forearm
E—Anterior carpal to flexor digitorum profundus
F—Posterior carpal to fifth metacarpal

XVIII—Radial
1—Origin
From bifurcation of radial to one-half inch below elbow
2—Termination
Deep palmar arch
3—Branches
A—Radial recurrent, supplies elbow joint
B—Muscular, to muscles on the radial side
C—Superficial volae completes superficial palmar arch
D—Anterior carpal to carpus
E—Posterior carpal to posterior part of carpus
F—Metacarpal supplies index and middle finger
G—Dorsalis indicis, runs along the index finger
H—Princeps pollicis, along thumb
I—Volar radialis indicis (radialis indicis), index finger

LYMPHATIC SYSTEM

A—COMPOSITION

I—Set of capillaries which absorb material from tissue and intest
(lacteal). These vessels pass through glands and empty into r
ceptaculum chyli. Arranged in two sets, superficial near skin
deep in relation with viscera. Certain structures devoid of lym
phatic glands are brain, cord, muscles, tendons, cartilage, eye,
nails, hair and teeth

II—Lymphatic glands or conglobate glands, pinkish-gray color. In course of lymphatic and lacteal vessels have a hilus at one border. The gland is divided into a cortical and medullary portion; vessels enter as afferent and leave as efferent vessels

III—Thoracic duct. Begins at a pouch called receptaculum chyli opposite second lumbar vertebra, passes through aortic opening of diaphragm, at the level of the seventh cervical vertebra and empties into left subclavian, fifteen inches long and drains all body except right upper quadrant

IV—Right lymphatic duct. Short thick trunk, one inch in length, drains right upper quadrant and empties into the right subclavian vein

B—SPECIAL SETS

I—Lymphatics head and neck

Consists of superficial and deep lymphatic vessels and glands, important vessels, following arteries. Glands situated on lateral areas of neck and angle of jaw

II—Lymphatics of trunk

Classified into parietal and visceral set

III—Lymphatics of upper extremity

1—Superficial set, beneath skin

2—Deep set follow blood vessels

IV—Lymphatics of abdomen

1—Parietal set in hypogastric lumbar and epigastric region

2—Visceral

A—Mesenteric glands one hundred in number

B—Liver set

C—Stomach set

D—Spleen set

E—Kidney set

V—Lymphatics of pelvis

Situated around organs in pelvis

VI—Lower extremity

Inguinal glands
- A—Superficial; eight to ten along inguinal (Poupart's) ligament. Deep set around saphenous opening
- B—Deep inguinal glands
  - Follow the arteries

Lymphatic vessels
- A—Superficial set lie in superficial fascia
- B—Deep set follow blood-vessels

VEINS

A—DEFINITION

Vessels that carry venous blood to heart for oxygenation

Recognized by:

1—Not pulsating
2—By having thinner coats
3—By swelling toward the periphery when compressed centrally
4—By being softer and less resisting to touch
5—By the flat ribbon-like feeling throughout their whole width when compressed between the fingers
6—By their purplish color
7—By their wavy irregular contour
8—By their accompanying the arteries in many regions in pairs or companion veins
9—By their larger size than the corresponding arteries
10—By the ease with which they are compressed

B—CLASSIFICATION

I—Superficial, return blood from superficial areas. Lie between layers of superficial fascia, not accompanied by arteries

II—Deep; enclosed in same sheath as artery but when in company of an artery of secondary caliber, they are placed on each side of the artery, and are called vena comites

III—Sinuses, confined to special organs

SINUSES OF DURA MATER

C—CLASSIFICATION

Single
- Superior sagittal sinus (superior longitudinal sinus)
- Inferior sagittal sinus (inferior longitudinal sinus)
- Straight sinus

Circular sinus
Transverse sinus

Double

Occipital sinuses
Lateral sinuses
Cavernous sinuses
Superior petrosal sinuses
Inferior petrosal sinuses

D—DESCRIPTION

I—Superior sagittal (superior longitudinal) sinus. Begins at the foramen caecum, runs in upper margin of falx cerebri and ends at the confluens sinuum (torcular herophili); receives superficial veins of the hemispheres

II—Inferior sagittal (inferior longitudinal) sinus runs along free margin of the falx cerebri, ends in the straight sinus

III—Straight sinus receives blood from inferior sagittal sinus. Extends to confluens sinuum (torcular)

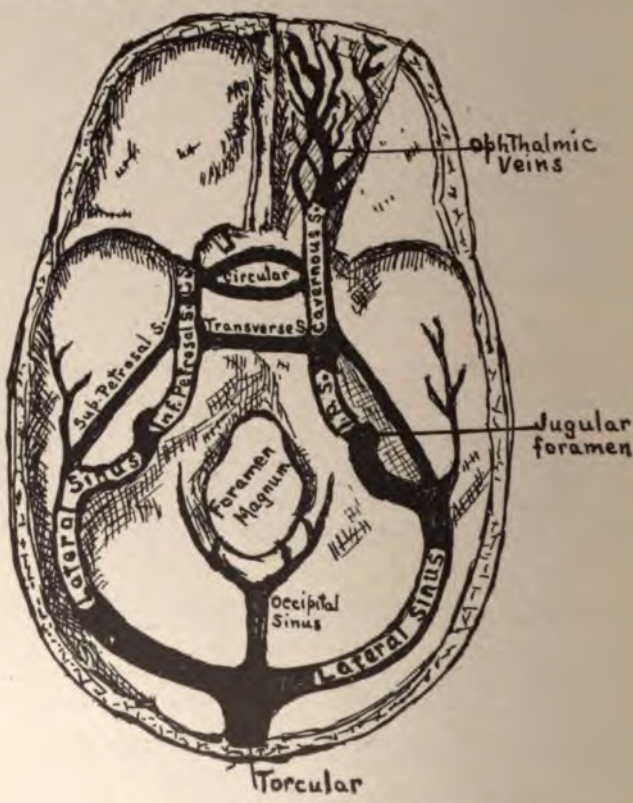


FIG. 164.—Sinuses at Base of Skull

IV—Circular sinus, enclosed in a process of dura mater that encloses the pituitary body

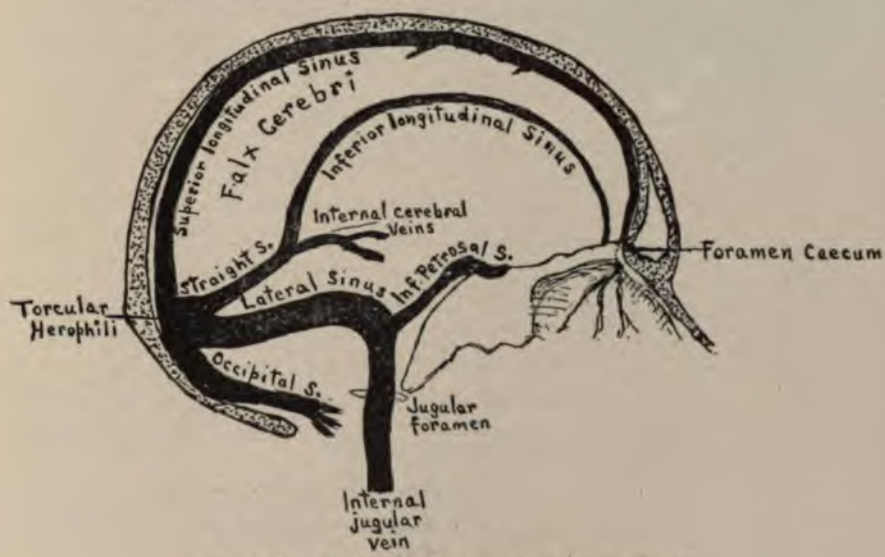


FIG. 165.—Sinuses of Dura (Sagittal Section)

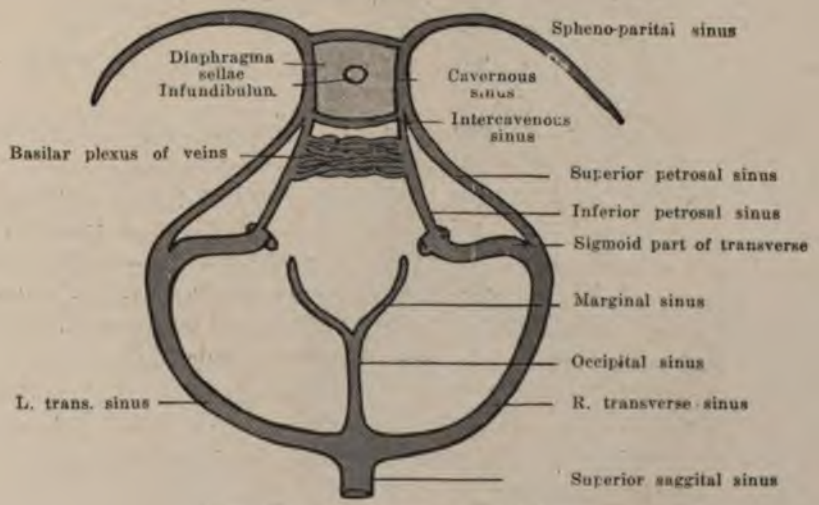


FIG. 166.—Sinuses on Base of Cranium

V—Transverse sinus connects cavernous and inferior petrosal sinuses

VI—Occipital contained in falx cerebelli opens into the confluens sinuum (torcular)

VII—Cavernous sinus, drains ophthalmic veins and empties into the internal jugular vein

VIII—Cavernous sinus, drains ophthalmic veins and empties into the inferior petrosal sinuses

IX—Superior petrosal connects cavernous with lateral sinus

X—Inferior petrosal, drains the cavernous sinus and empties into internal jugular vein

XI—Emissary veins

These are communications between the sinuses and the veins outside the cranium

A—Vein through the foramen caecum, forms a communication between superior sagittal sinus (superior longitudinal) and the nasal mucous membrane

B—Vein through the mastoid foramen forms a communication between the lateral or transverse sinus and the posterior auricular and occipital veins

C—Vein through the posterior superior angle of the parietal forms a communication between the superior sagittal sinus and the veins of scalp

D—Veins through the posterior condyloid foramen form a communication between the lateral or transverse sinus and the deep veins of the neck

E—Vein through the anterior condyloid foramen forms a communication between the occipital sinus and the deep veins of the neck

F—Ophthalmic veins connect the cavernous sinus with the angular vein

G—Minute veins through the foramen ovale connect the cavernous sinus and the pharyngeal and pterygoid veins

H—Communications between the frontal diploic and supra-orbital veins, between the anterior temporal diploic and the deep temporal veins and between the posterior temporal and occipital diploic veins and the transverse sinus

XII—External jugular veins, formed by union of posterior auricular and temporo-maxillary and empties into subclavian

XIII—Internal jugular, formed by union of lateral and inferior petrosal sinus. Unites with subclavian to form innominate veins which in turn unite to form the superior vena cava

XIV—Superior vena cava

Returns the blood from the

A—Head

B—Neck

C—Upper extremity

D—Thoracic wall

E—Portion of upper part of posterior wall of the abdomen

It is formed behind the first right costal cartilage by the union

of the two innominate veins and descends with a slight convexity to the right to the level of the third right costal cartilage

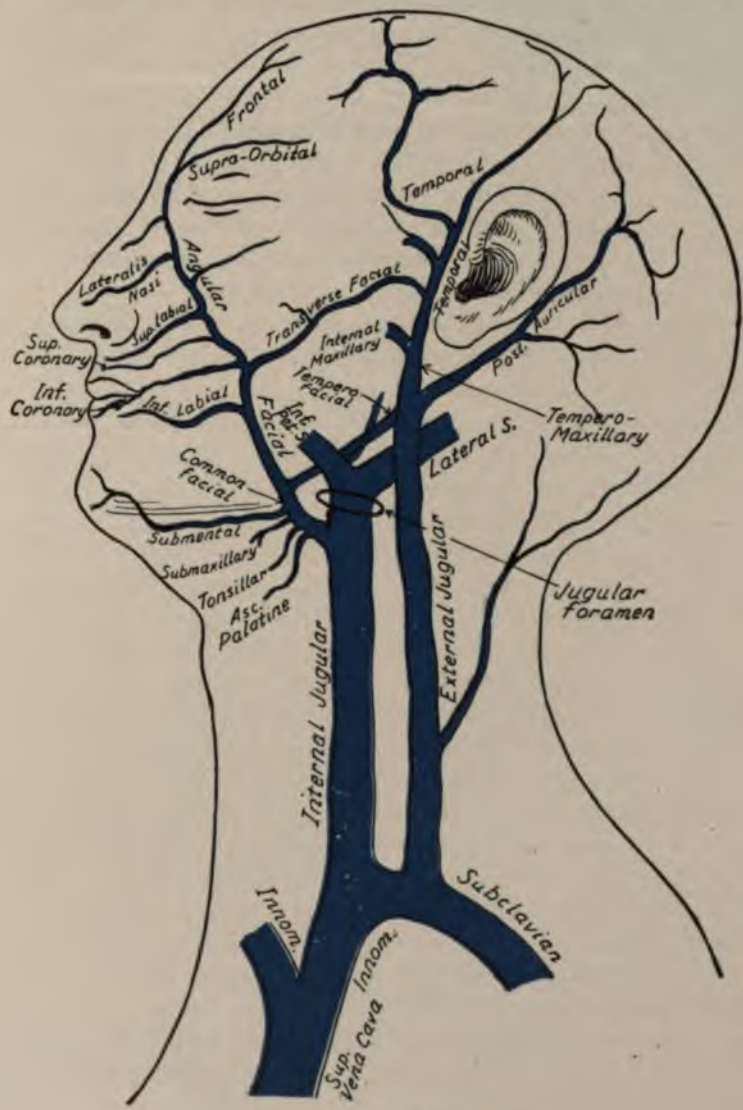


FIG. 167.—Superficial Veins—Head

where it opens into the upper and back part of the right auricle. The lower half is within the pericardium. Its tributaries are:

A—Vena azygos major
B—Pericardial
C—Mediastinal veins

XV—Inferior vena cava

Formed by two common iliacs between the fourth and fifth lumbar vertebrae. Length about eight inches and empties into the right auricle

XVI—Azygos veins

Connecting links between superior and inferior vena cava; also collects blood from intercostal spaces

A—Vena azygos major (right)

Arises from lumbar veins, inferior vena cava, or right renal vein. Passes through aortic opening in diaphragm. Empties into superior vena cava

B—Hemiazygos (vena azygos minor)

Arises from left lumbar or left renal vein

Passes through left crus of diaphragm, receives blood from

1—Five lower intercostal veins

2—Mediastinal veins

3—Esophageal vein

4—Spinal vein

Empties into azygos major at the sixth thoracic vertebra

C—Hemiazygos accessory (left superior azygos major collects blood from upper intercostal and terminates in azygos major)

XVII—Portal veins, formed by union of gastric, splenic and mesenteric veins, enters liver at the transverse fissure and breaks up into a series of veins called interlobular which run between lobules. Enters the lobule and are called intra lobular or central sublobular. All unite to form hepatic vein which empties into the inferior vena cava

XVIII—Veins of Pelvis

Hypogastric (internal iliac)

Visceral branches

Hemorrhoidal

Vesicle

Prostatic

Uterine

Vaginal

Non-visceral branches

Obturator

Sciatic

Pudic

Ilio-lumbar

Lateral sacral

Gluteal

Hemorrhoidal veins of importance, because they afford communication between the portal and general systemic veins

XIX—Veins of upper extremity

Superficial veins

Radial

Anterior ulnar

Posterior ulnar

Median

Median basilic

Cephalic

Basilic

Deep veins

Axillary vein

Subclavian vein

Anterior and posterior ulnar pass up into arm and unite with median basilic to form the basilic

Radial unites with the median cephalic to form the cephalic

Median from the palm of the hand passes to the elbow

Divides into median cephalic and median basilic

XX—Veins of lower extremity

Superficial veins

Saphenous parva (external short saphenous)

Begins at the outer end of the arch on the outer side of the foot; it passes upward behind the external malleolus, up along the outer side of the tendo calcaneous (Achille) with the saphenous parva nerve, to the popliteal space where it enters the popliteal vein

Saphena magna (internal long saphenous)

Begins at the inner end of arch on the inner side of the foot. It passes upward in front of the internal malleolus, then upward and backward with the internal saphenous nerve. Behind the internal condyle of the femur, then upward and outward to the inner side of front of the thigh through the saphenous opening to empty into the femoral vein

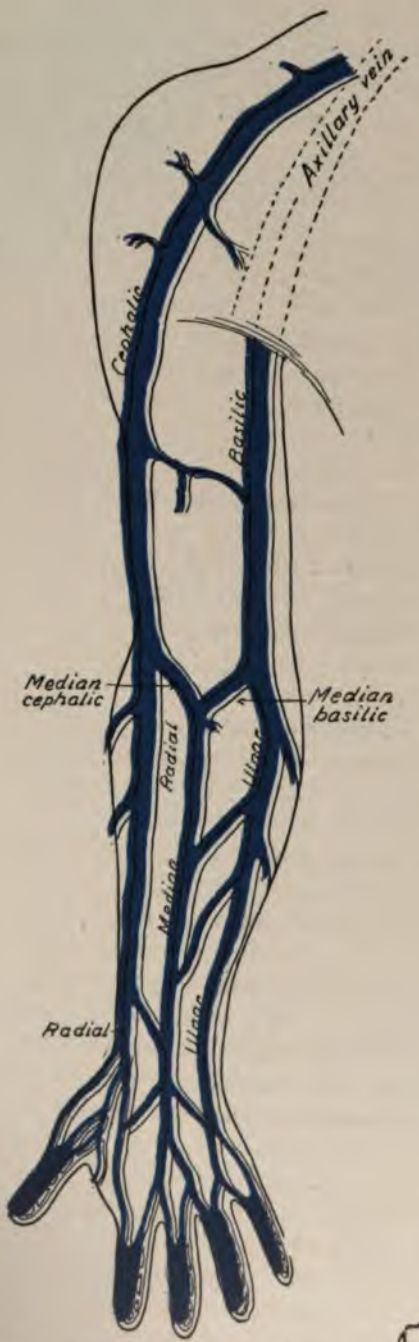


FIG. 168.—Superficial Veins of Upper Extremity

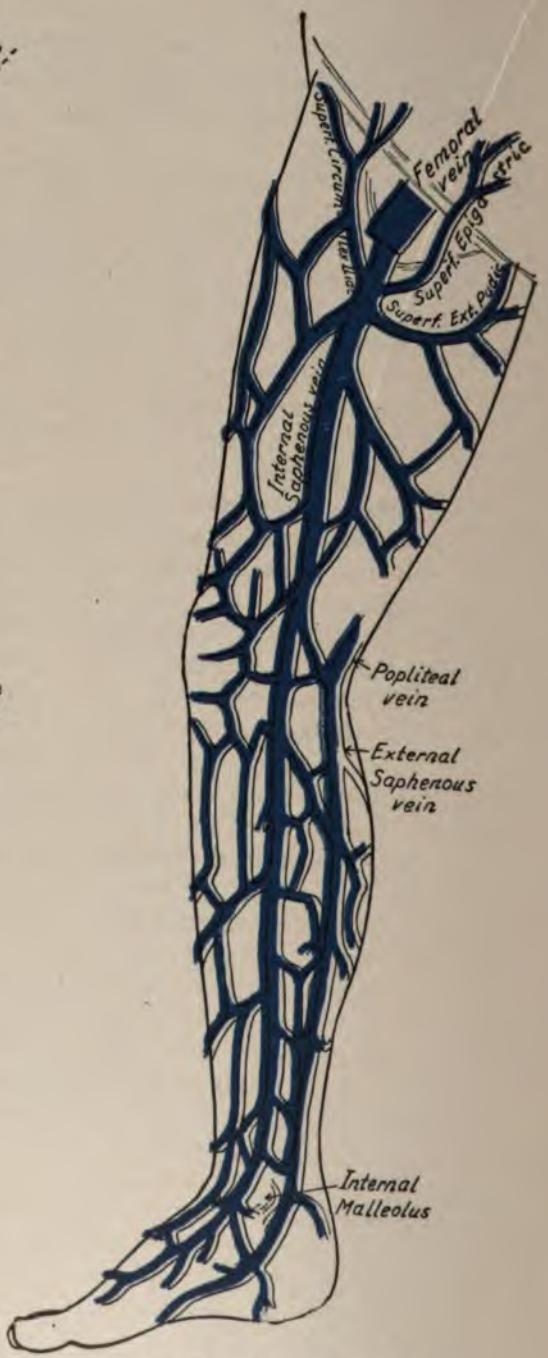


FIG. 169.—Superficial Veins of Leg

GLOSSARY

THE HEART AND BLOOD VESSELS

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
HEART	
Atrium	Auricle
Auricula cordis	Auricular appendix
Incisura cordis	Notch at apex of heart
Tabeculae carnae	Columnae carneae
Tuberculum intervenosum	Intervenous tubercle of Lower
Sulcus longitudinalis anterior	Anterior interventricular groove
Sulcus coronarius	Auriculo-ventricular groove
Limbus fossae ovalis	Annulus ovalis
Valvula venae cavae	Eustachian valve
Valvula sinus coronarii	Valve of Thebesius
ARTERIES	
Sinus aortae	Sinuses of Valsalva
A. profunda linguae	Ranine artery
A. maxillaris externa	Facial artery
A. alveolaris inferior	Inferior dental artery
Ramus meningeus accessorius	Small meningeal artery
A. buccinatoria	Buccal artery
A. alveolaris superior posterior	Posterior superior dental artery
A. alveolares superiores anteriores	Anterior superior dental artery
Ramus carotico-tympanicus	Tympanic branch of int. carotid
A. choroidea	Anterior choroidal artery
A. auditiva interna	Auditory artery
Rami ad pontem	Transverse arteries (branches of basilar artery)
A. pericardiaco-phrenica	Arteria comes nervi phrenici
Rami intercostales	Anterior intercostal arteries
Truncus thyreo-cervicalis	Thyroid axis
A. transversa scapulae	Suprascapular artery
A. intercostalis suprema	Superior intercostal
A. transversa colli	Transversalis colli
A. thoracalis suprema	Superior thoracic artery
A. thoraco-acromialis	Acromio-thoracic artery

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
A. thoracalis lateralis	Long thoracic artery
A. circumflexa scapulae	Dorsalis scapulae
A. profunda brachii	Superior profunda
A. collateralis radialis	Anterior branch of superior profunda
A. collateralis ulnaris superior	Inferior profunda
A. collateralis ulnaris inferior	Anastomotica magna
Ramus carpeus volaris	Anterior radial carpal
Ramus carpeus dorsalis	Posterior radial carpal
Aa. metacarpae dorsales	Dorsal interosseous arteries
A. volaris indicis radialis	Radialis indicis
Arcus volaris profundus	Deep palmar arch
Arcus volaris superficialis	Superficial palmar arch
A. interossea dorsalis	Posterior interosseous artery
A. interossea recurrens	Posterior interosseous recurrent artery
A. interossea volaris	Anterior interosseous artery
Ramus carpeus dorsalis	Posterior ulnar carpal
Ramus carpeus volaris	Anterior ulnar carpal
Aa. digitales volares communes	Palmar digital arteries
Aa. digitales volares propriae	Collateral digital arteries
Arteriae intestinales	Intestinal branches of superior mesenteric
A. suprarenalis media	Middle capsular artery
A. hypogastrica	Internal iliac artery
A. umbilicalis	Obliterated hypogastric
A. pudenda interna	Internal pudic artery
A. epigastrica inferior	Deep epigastric artery
A. spermatica externa	Cremasteric artery
Aa. pudendae externae	Superficial and deep external pudic arteries
A. circumflexa femoris medialis	Internal circumflex artery
A. circumflexa femoris lateralis	External circumflex artery
A. genu suprema	Anastomotica magna
A. genu superior lateralis	Superior external articular artery
A. genu superior medialis	Superior internal articular artery

BNE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
A. genu media	Azygos articular artery
A. genu inferior lateralis	Inferior external articular artery
A. genu inferior medialis	Inferior internal articular artery
A. malleolaris anterior medialis	Internal malleolar artery
A. maleolaris anterior lateralis	External malleolar artery
A. Peronaea	Peroneal artery
Ramus perforans	Anterior peroneal artery
A. malleolaris posterior lateralis	Posterior peroneal artery
A. malleolaris posterior medialis	Internal malleolar artery
Rami calcanei laterales	External calcanean artery
Rami calcanei mediales	Internal calcanean artery
A. plantaris medialis	Internal plantar artery
A. plantaris lateralis	External plantar artery
Aa. metatarsae plantares	Digital branches
Aa. digitales plantares	Collateral digital branches
ss	
V. cordis magna	Great cardiac vein
V. obliqua atrii sinistri	Oblique vein of Marshall
Lig. venae cavae sinistrae	Vestigial fold of Marshall
Vv. cordis minimae	Veins of Thebesius
Sinus transversus	Lateral sinus
Confluens sinuum	Torcular Herophili
Plexus basilaris	Basilar sinus
Sinus sagittalis superior	Superior longitudinal sinus
Sinus sagittalis inferior	Inferior longitudinal sinus
Sinus spheno-parietalis	Sinus alae parvae
V. cerebri internae	Veins of Galen
V. cerebri magna	Vena magna Galeni
V. terminalis	Vein of the corpus striatum
V. basalis	Basilar vein
V. transversa scapulae	Suprascapular vein
V. thoraco-acromialis	Acromio-thoracic vein
Vv. transversae colli	Transversalis colli veins
V. thoracalis lateralis	Long thoracic vein
V. azygos	Vena azygos major
V. hemiazygos	Vena azygos minor inferior
V. hemiazygos accessoria	Vena azygos minor superior
V. hypogastrica	Internal iliac vein

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
V. epigastrica inferior	Deep epigastric vein
V. saphena magna	Internal saphenous vein
V. saphena parva	External saphenous vein
LYMPHATICS	
Cisterna Chyli	Receptaculum chyli

NERVOUS SYSTEM

DEFINITION

Complex arrangement of neurons, which serves to adapt the individ to his surroundings

CLASSIFIED

Central
- 1—Brain
- 2—Spinal cord

Peripheral
- 1—Spinal nerves
- 2—Cranial nerves
- 3—Sympathetic nerves

BRAIN

DEFINITION

That division of the central nervous system situated in the cran vault

FUNCTION

Reception, classification and projection of impulses

COVERINGS

I—Dura mater; A thick fibrous membrane
- 1—Function
  - A—Endosteal
  - B—Protects the brain
  - C—Supports the brain by processes
    - a—Falx cerebri, between hemispheres of cerebrum
    - b—Falx cerebelli, between cerebellum
    - c—Tentorium cerebelli, between cerebellum and cerebrum
    - d—Diaphragm sellae over sellae tursica
  - D—Forms sinuses
  - E—Sheaths of nerves

F—Upper surface gives off processes called arachnoid granulations (Pacchionian bodies)

2—Arachnoid mater, two layers parietal against dura, visceral against brain. Function: lubrication. Beneath the visceral layer is the subarachnoidian space. Contains cerebro-spinal fluid which communicates with the ventricles

3—Pia mater. Vascular membrane. Function: nutrition of brain. Dips into sulci and ventricle, forms choroid plexus and choroid tela of the third ventricle (velum interpositum)

WEIGHT

Male 50 ounces. Female 45 ounces

Cerebrum 44 ounces

Cerebellum 5 ounces

Pons and medulla ½ ounce

EMBRYOLOGY

Developed from the ectoderm. A depression is formed called the neural groove. Edges of this groove overlap and form the neural canal which divides into three primary vesicles

1—Anterior vesicle

A—Anterior cavity forms lateral ventricle and brain around lateral ventricles called prosencephalon or forebrain

B—Posterior cavity forms third ventricle and brain around called thalamencephalon or inter-brain

2—Middle vesicle

Forms cerebral aqueduct (aqueduct of Sylvius) and brain around called mesencephalon or mid-brain

3—Posterior vesicle

Forms the fourth ventricle and brain around called epencephalon or pons and cerebellum or hind brain and metencephalon or after-brain

HISTOLOGY

Gray matter externally (nerve cells)

White matter internally (nerve processes)

DIVISIONS FOR DESCRIPTION

I—Prosencephalon. Cerebrum of forebrain

II—Thalamencephalon. Interbrain

III—Mesencephalon. Mid-brain

IV—Epencephalon. Pons and cerebellum hind-brain

V—Metencephalon. Medulla or after-brain

CEREBRUM

DEFINITION

Largest portion of brain divided into two lateral halves by longitudinal fissure. Held together by commissure called the corpus callosum. Each hemisphere shows outer surface which is convex and inner surface flattened and an under surface or base

ANATOMY

Gross

1—Outer surface

A—Lobe

a—Frontal, bounded below by the lateral cerebral fissure (Sylvius), behind by central sulcus (fissure of Rolando); lower portion rests upon the orbital plate of the frontal bone

b—Parietal, bounded in front by central sulcus, behind by the parieto occipital fissure, below by the lateral fissure (Sylvius)

c—Occipital, situated behind parietal lobe and situated on the tentorium cerebelli

d—Temporo-sphenoidal, below, temporal and occipital lobe

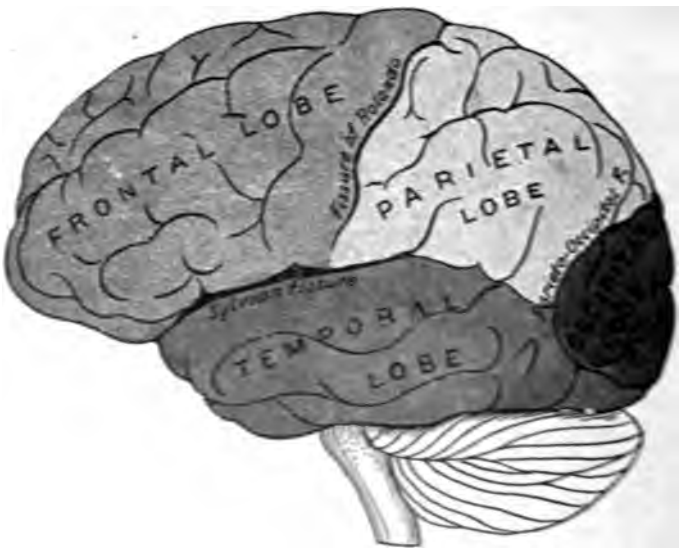


FIG. 17.—Diagram of Lobes of Brain

B—Principal fissures
- a—Median longitudinal separates two cerebrums
- b—Lateral fissure (Sylvius) from anterior perforated space at base of brain to about middle point on outside of cerebrum. Divides into ascending and longitudinal limb
- c—Central sulcus (fissure of Rolando) between frontal and parietal lobes

2—Inner surface shows for examination
- A—Sulcus Cinguli (callosal marginal fissure)
- B—Ponto occipital fissure
- C—Calcarine fissure
- D—Corpus callosum
- E—Fornix
- G—Cuneus
- H—Precuneus
- I—Para central lobule
- J—Gyrus fornicatus

3—Base of cerebrum

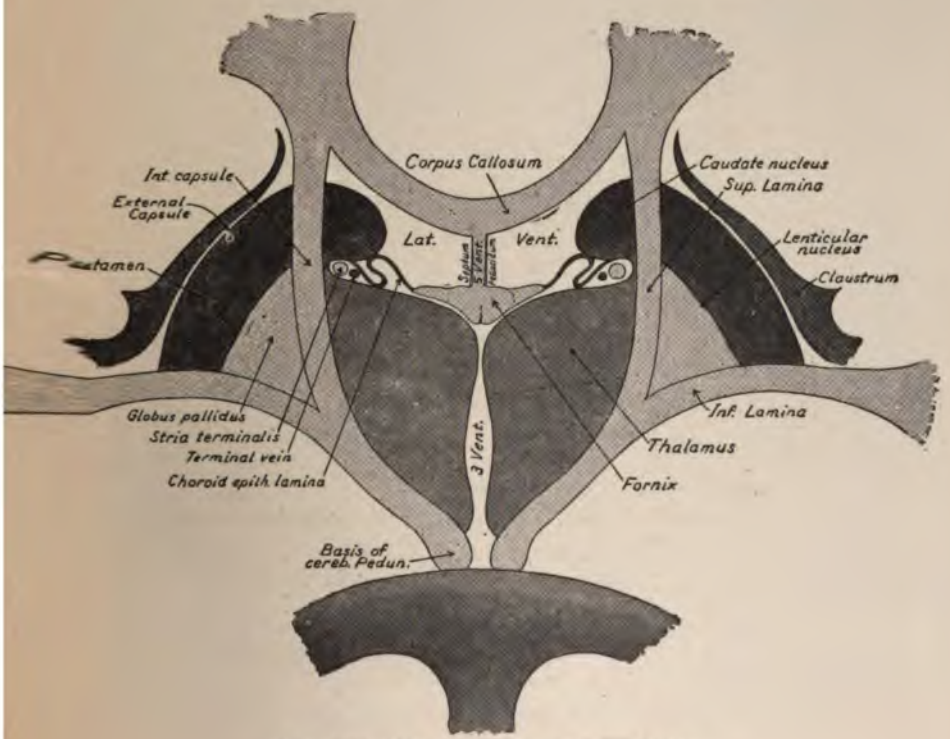


FIG. 171.—Interior Surface of Fore-brain

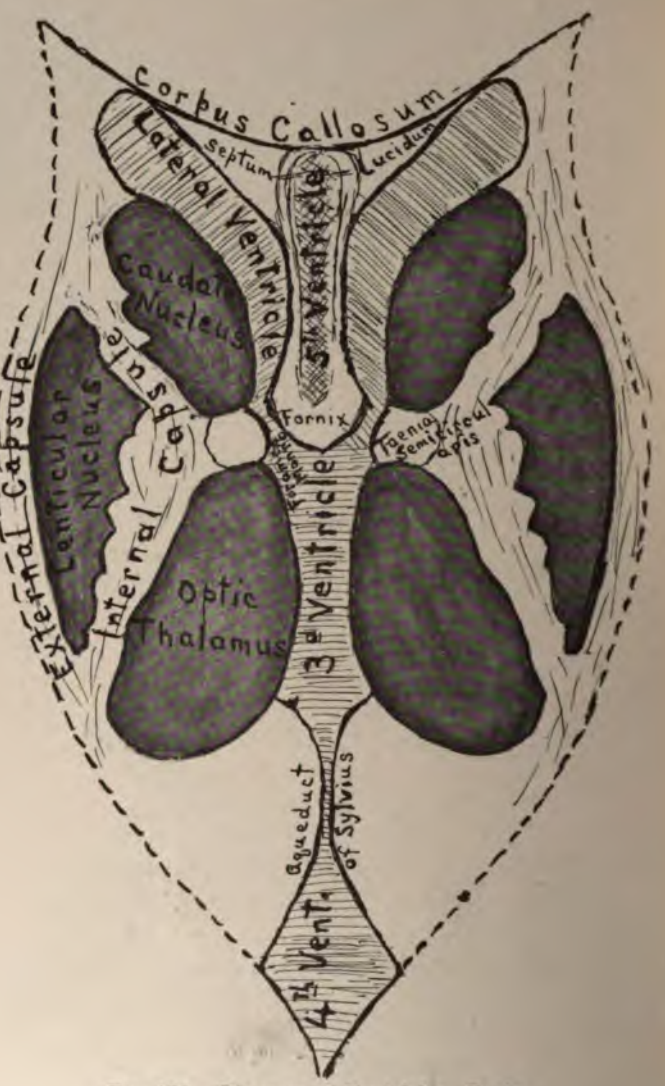


FIG. 172.—Diagram of Ventricles—Brain

A—Shows:

a—Longitudinal fissure separates the two hemis

b—Corpus callosum. Great transverse commi
Connects the two hemispheres

c—Lamina cinerea. Thin layer of gray matte
nects corpus callosum to tubercinereum

d—Lateral fissure (Sylvius)

e—Anterior perforated spot admits vessels to c
striatum

f—Optic commissure formed by union of the optic tracts
g—Tubercinereum. Lamina of gray matter extends from corpus albicantia to optic commissure
h—Infundibulum process of brain substance which connects base of brain to floor of third ventricle
i—Corpora albicantia or mamillaria. Two round white eminences in front of posterior perforated space
j—Cerebral peduncles (crura cerebrate) connects cerebrum with spinal cord
k—Pituitary body lies in sella tursica
l—Posterior perforated space

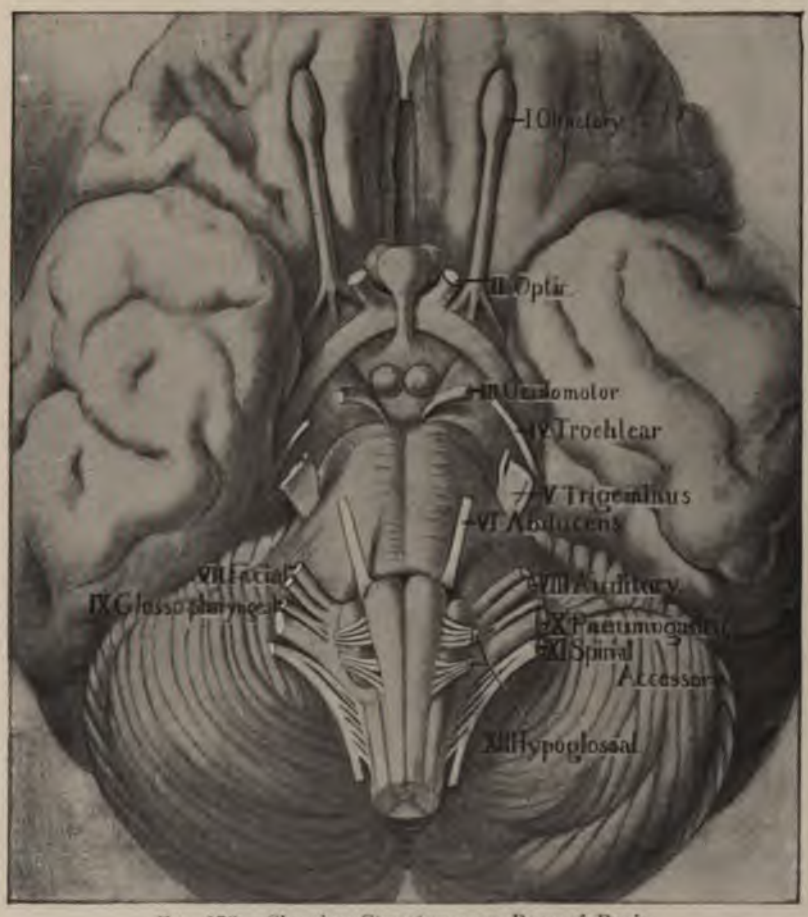


FIG. 173.—Showing Structures on Base of Brain

4—The interior

A—Corpus callosum

The commissure of the cerebrum. The fibers pass from one hemisphere to another, forming the roof of the lateral ventricle of each hemisphere; on upper surface is a raphe, on either side are the nerves of Laucisi

B—Lateral ventricles

Situated within the substance of the cerebrum

Boundaries

Front

Brain substance and anterior cornu

Behind

Brain substance and anterior cornu

Externally

Brain substance and middle cornu

Internally

Septum lucidum

Above

Corpus callosum

Below

Corpus striatum
Taenia semicircularis
Optic thalamus
Choroid plexus of veins
Corpus fimbriatum
Fornix

Anterior cornua. Passes over the anterior extremity of the corpus striatum

Middle cornua. Curved like the horn of a ram.

On floor is seen

A—Hippocampus (hippocampus major)
B—Hippocampus digitations (pes hippocampi)
C—Corpus fimbriatum
D—Choroid plexus
E—Fascia dentata
F—Transverse fissure

Posterior cornua

Curves into occipital lobe

C—Corpus striatum

Superior ganglion of the cerebrum. Pyriform in shape, larger and directed forward; receives name from striped appearance

D—Taenia semicircularis
Narrow band of white fibers which connects the corpus striatum and optic thalamus

E—Optic thalamus
White oblong mass, situated on the crus cerebri
Boundaries
Externally
Corpus striatum
Stria terminalis (Taenia semicircularis)
Internally
Forms lateral boundaries of third ventricle
Superiorly
Covered by fornix
Inferiorly
Projects into descending cornua and presents internal and external geniculate bodies

F—Choroid plexus
Vascular fringe-like membrane formed by process of pia mater connected to opposite one by foramen interventriculare (foramen of Monro)

G—Corpus fimbriatum
Thin ribbon like edge of fornix

H—Fornix
Triangular in shape, broadest in front. Beneath corpus callosum, divided into two crura forms corpora albicantia

I—Fifth ventricle
Space between two layers of septum pellicidum (lucidum)

J—Third ventricle
Definition
Narrow fissure between optic thalami extending to the base of the brain
Boundaries
Roof
Fornix and velum interpositum
Floor
Structures on base of brain within the circle of Willis
Anteriorly
Anterior commissure connecting the corpora striata

Posteriorly

Posterior commissure connecting optic thalami

Description

Crossed by three commissures: anterior, middle, and posterior

Openings

1—Two apertures for interventricular foramen (Monro)

2—Opening into fourth ventricle cerebral aqueduct (Sylvius)

K—Pineal gland

Conical, reddish-gray vascular body placed between the nates. Base connected to optic thalami by two anterior peduncles and to the posterior commissure by small inferior peduncles

L—Corpora Quadrigemina

Four little bodies composed of white matter outside, gray matter inside, placed in pairs behind the third ventricle; anterior pair called nates, posterior pair called testes. Two bands passing from cerebellum to testes called brachia

M—Superior medullary velum

Transparent medullary substance between brachia forming the roof of the fourth ventricle

N—Geniculate body

Two bodies on the back of the optic thalami

O—Fourth ventricle

Definition

Diamond shaped space situated on the posterior surface of medulla and pons

Boundaries

Floor

Posterior surface of medulla and pons

Roof

Superior medullary velum

Laterally

Above

Superior peduncles

Below

Restiform body

Communications

With third ventricle by the cerebral aqueduct (of Sylvius)

Description

On floor, is a median groove continuous with central canal of the cord on either side a small eminence, fasciculus teres. Lower part is bounded by end of posterior pyramid and is termed calamus scriptorius. Locus coeruleus is a small whitish eminence opposite the cerebellar peduncles. The lower part of floor is crossed transversly by lines called linea transversa. Choroid plexus, vascular fringes on either side

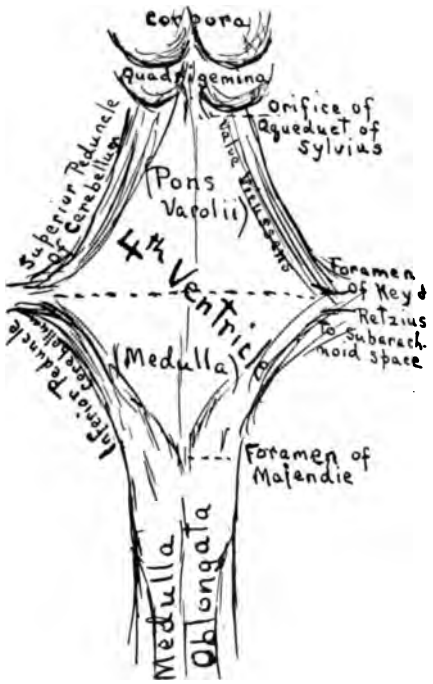


FIG. 174.—Diagram of Fourth Ventricle

MICROSCOPIC ANATOMY

Gray matter (nerve cells)

1—From without inward

A—Molecular layer

B—Small pyramidal layer

C—Large pyramidal layer

D—Polymorphous layer

White matter (nerve tracts)

1—Projection or peduncular fibers transmit impulses from brain to cord

2—Commissural fibers connect the two hemispheres
3—Association fibers associate the different levels of the brain

CEREBELLUM

DEFINITION

That part of the brain contained in the occipital fossa, separated from the cerebrum by tentorium cerebelli

WEIGHT

Five ounces

FORM

Oblong, flattened from above downward

SIZE

Two inches long, four inches wide, and two inches thick

STRUCTURE

Gray matter externally, white matter internally

UPPER SURFACE

Presents a ridge called superior vermiform process. Each half of cerebellum divided into anterior and posterior lobe

INFERIOR SURFACE

Divided into two lobes by a fissure which receives medulla, on floor of the fissure, the inferior vermiform processes is seen

INTERNAL STRUCTURE

On section shows corpus dentatum, a nucleus of gray matter from which ten to twelve lamina arise, called arbor vitae

1—Superior peduncle
Connects cerebellum to cerebrum
2—Middle peduncle
Connects two hemispheres
3—Inferior peduncle
Connects cerebellum to medulla

MEDULLA OBLONGATA

DEFINITION

That part of the brain which extends from lower border of the pons to lower border of foramen magnum

DIMENSIONS

Length 1¼ inches, width ¾ inch

SHAPE

Pyramidal, base to pons, apex to spinal cord

SURFACE

Anterior

Lies on basilar process of the occipital bone

Posterior

Forms lower half of the floor of the fourth ventricle

Fissures

Anterior and posterior median, continuous with those of the cord

DESCRIPTION

Each lateral half is divided into four columns named from within out

1—Anterior pyramid

Continuation of the anterior column of the cord

2—Olivary body

Oval body one-half inch long lying between pyramid and restiform body

3—Restiform

Continuous with posterior column of cord. Forms lateral boundary of the fourth ventricle, enters cerebellum and is called the inferior peduncle of the cerebellum

4—Posterior pyramid

Forms apex of the fourth ventricle

PONS (VAROLII)

DEFINITION

The bond of union of the various parts of the brain connecting cerebellum above with the medulla below and cerebellum behind

DIMENSIONS

Length is one inch and is wider transversely

SURFACES

Under

Convex, grooved in center for basilar artery

Upper

Smaller, continuous with posterior surface of bulb, forms upper part of floor of fourth ventricle

Laterally
Continuous with middle peduncles of cerebellum

STRUCTURE

Consists of alternate layers of transverse and longitudinal fibers intermixed with gray matter

SPINAL CORD

DEFINITION

That division of the central nervous system that occupies upper two-thirds of the spinal canal

EXTENDS

From the lower border of the foramen magnum to the lower border of the first lumbar vertebra

LENGTH

Sixteen to seventeen inches

WEIGHT

1½ ounces

SHAPE

Transverse section oval, elongated from side to side

ENLARGEMENTS

I—Cervical from second cervical to second dorsal, gives origin to brachial and cervical plexus
II—Lumbar, from 10th dorsal vertebra to first lumbar, gives origin to lumbar and sacral plexus

FISSURES

I—Anterior median fissure
Extends to one-third of thickness of cord
II—Posterior median fissure
Extends to one-half of the thickness of the cord

CENTRAL CANAL

In the interior of cord lined with spheroidal ciliated epithelium opening into cavity of the fourth ventricle

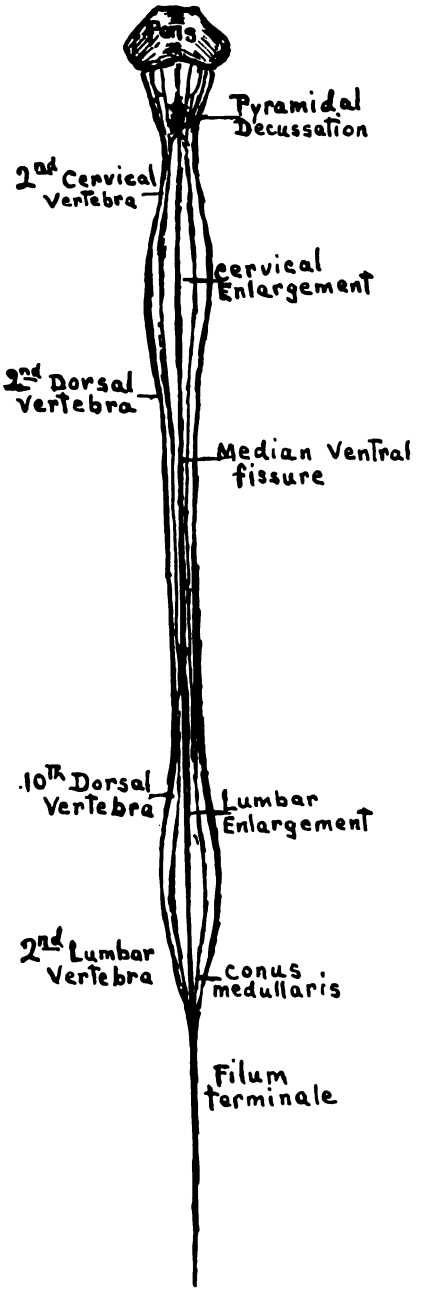


FIG. 175.—Diagram of Spinal Cord (Longitudinal View)

CROSS SECTION

Gray matter on inside arranged in figure 176, white matter on outside

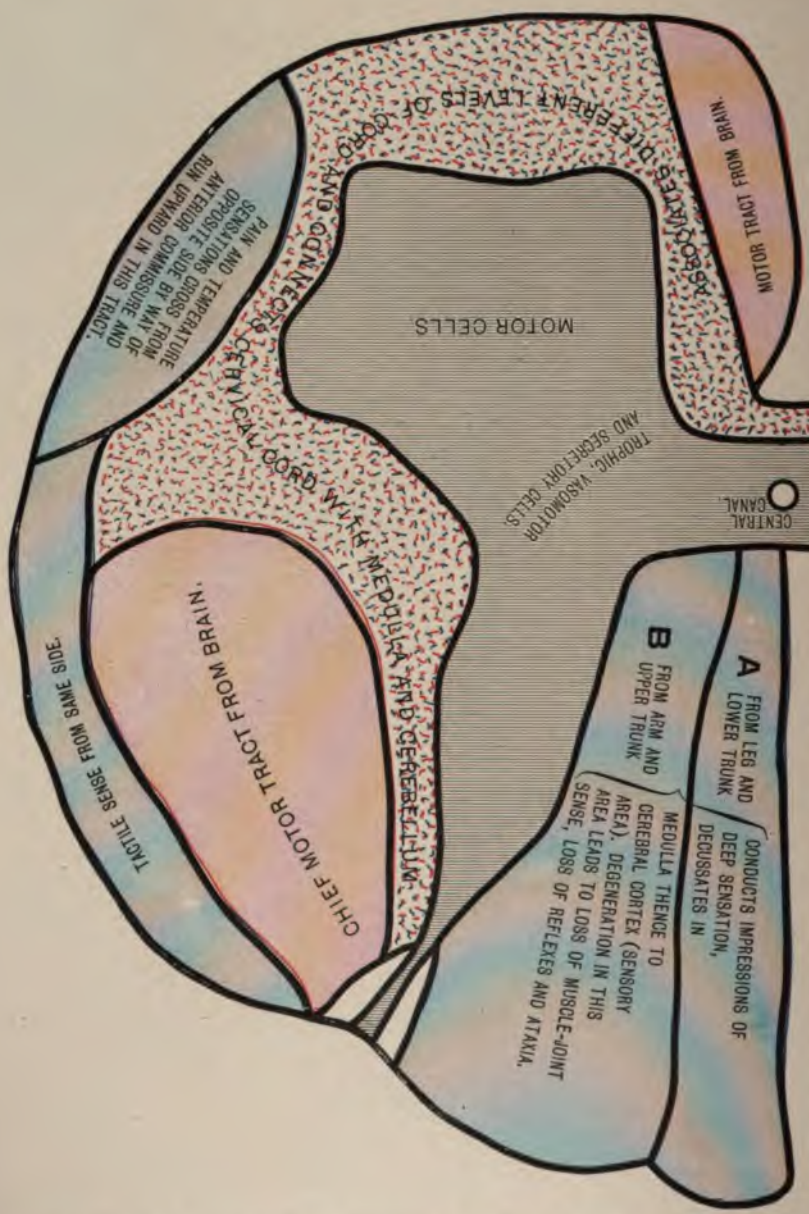

MOTOR TRACT FROM BRAIN
ASSOCIATES DIFFERENT LEVELS OF CORD AND CONNECTS
MOTOR CELLS
TROPHIC, VASOMOTOR AND SECRETORY CELLS
CENTRAL CANAL
PAIN AND TEMPERATURE SENSATIONS CROSS FROM OPPOSITE SIDE BY WAY OF ANTERIOR COMMISSURE AND RUN UPWARD IN THIS TRACT.
GRAY MATTER OF CORD WITH MEDULLA AND CEREBELLUM
CHIEF MOTOR TRACT FROM BRAIN.
TACTILE SENSE FROM SAME SIDE.
A FROM LEG AND LOWER TRUNK
CONDUCTS IMPRESSIONS OF DEEP SENSATION, DECUSSATES IN
B FROM ARM AND UPPER TRUNK
MEDULLA THENCE TO CEREBRAL CORTEX (SENSORY AREA). DEGENERATION IN THIS AREA LEADS TO LOSS OF MUSCLE-JOINT SENSE, LOSS OF REFLEXES AND ATAXIA.

FIG. 176.—Diagram of the Cross Section of Cord, Showing the Tracts of the Spinal Cord and their Varied Nomenclature
Red—motor (or efferent)
Blue—sensory (or afferent)

PRINCIPAL COLUMNS OF THE SPINAL CORD

I—In the posterior column are

1—Postero-internal column (or column of Goll) which conducts to the brain special sensations from muscles, tendons, and joints of the same side

2—Postero-external column (or column of Burdach) which con-

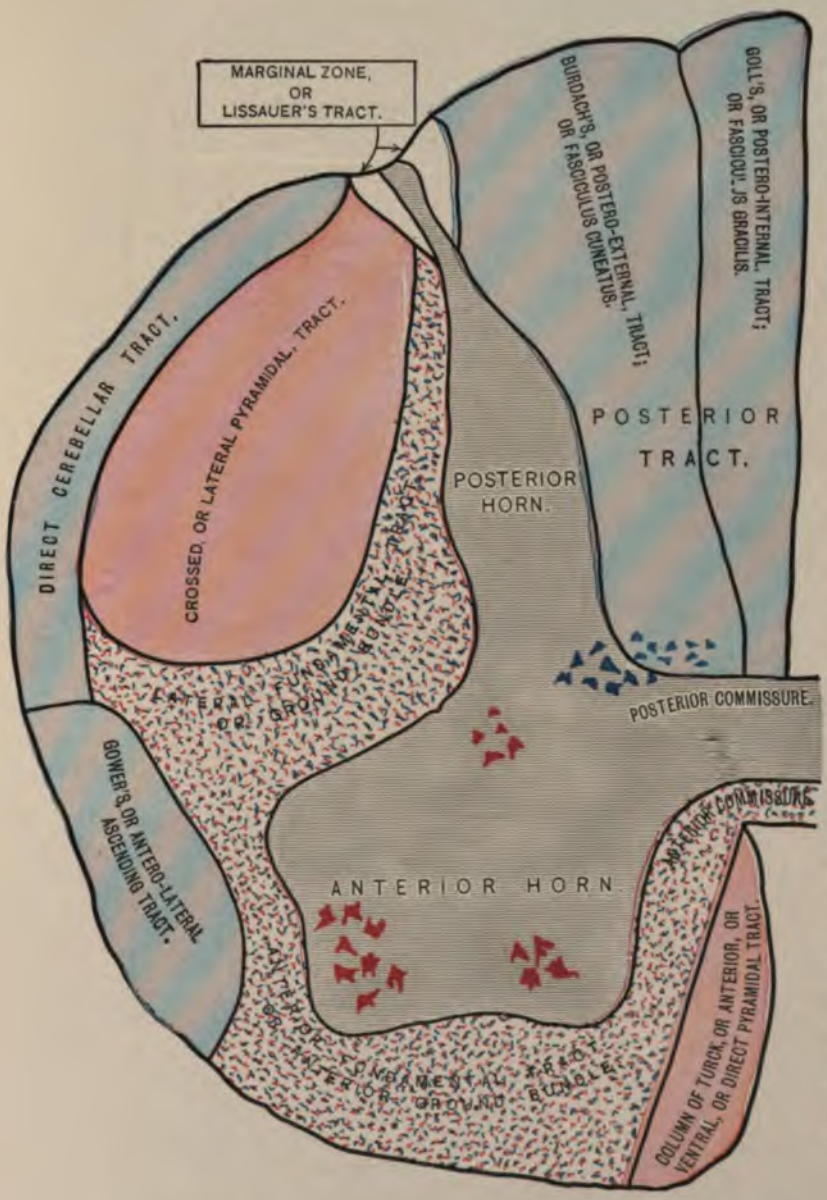

MARGINAL ZONE, OR LISSAUER'S TRACT.
BURDACH'S, OR POSTERO-EXTERNAL, TRACT; OR FASCICULUS CUNEATUS.
GOLL'S, OR POSTERO-INTERNAL, TRACT; OR FASCICULUS GRACILIS.
DIRECT CEREBELLAR TRACT.
CROSSED, OR LATERAL PYRAMIDAL, TRACT.
POSTERIOR HORN.
POSTERIOR TRACT.
POSTERIOR COMMISSURE.
GOWER'S, OR ANTERO-LATERAL ASCENDING TRACT.
ANTERIOR HORN.
COLUMN OF TÜRCK, OR ANTERIOR, OR VENTRAL, OR DIRECT PYRAMIDAL TRACT.

Fig. 176a.—Diagram of the Cross Section of Cord, Showing the Functions of the Various Tracts of the Spinal Cord

Red—motor (or efferent) Blue—sensory (or afferent)

ducts to the brain tactile sensations from the opposite side and also contains association fibers

II—In the lateral column are:

1—Anterolateral tract of Gower, which conducts to the brain sensations of touch, pain, and temperature from the opposite side of the body

2—Anterior and lateral ground bundles, which connect different levels of the spinal cord with each other, and also connect the cord with the medulla and cerebellum. (They contain both motor and sensory fibers)

3—Crossed or lateral pyramidal column, which is the chief motor tract from the brain

4—Direct cerebellar tract, which conducts to the brain sensations from the viscera and also assists in the maintenance of equilibrium

III—In the anterior column are:

1—Direct pyramidal tract, which is a motor tract from the brain

2—Anterolateral ground bundle, which connects different levels of the cord

COVERINGS

I—Dura mater

II—Arachnoid

III—Pia mater

Anteriorly shows thickening called linea splendens

Laterally, shows ligamentum denticulatum between anterior and posterior roots of nerve, consists of a number of filaments attached to dura mater and serves to support the cord

CONTENTS OF NEURAL CANAL

Venous plexus between bone and dura mater

Membranes

Dura mater

Arachnoid

Parietal layer

Visceral layer

Pia mater with ligamenta denticulata

Cerebrospinal fluid

Spinal vessels

Anterior spinal artery and vein

Two posterior spinal arteries and veins

Spinal cord, with anterior and posterior roots of nerves

CRANIAL NERVES

TWELVE IN NUMBER

Classified

Physiologically

A—Special sense

a—Olfactory
b—Optic
c—Auditory
B—Mixed
a—Trigeminal or tri-facial
b—Glosso-pharyngeal
c—Vagus or pneumogastric
C—Motor
a—Oculi motor
b—Trochlear
c—Abducens
d—Facial
e—Spinal accessory
f—Hypoglossal

Anatomically
1—Olfactory
2—Optic
3—Motor oculi
4—Trochlear
5—Trigeminal
6—Abducens
7—Facial
8—Auditory
9—Glosso-pharyngeal
10—Vagus
11—Spinal accessory
12—Hypoglossal

I—Olfactory nerve

Origin

Superficial

Under surface of olfactory lobe

Deep

External root, limbic lobe
Middle root, optic thalamus
Internal root, limbic lobe

Distribution

External filament to Schneiderian membrane over superior concha and ethmoid bones. Internal filaments to septum (upper third)

Exit

Ethmoidal foramena, twenty in number in the cribriform plate of the ethmoid bone

Function

Smell

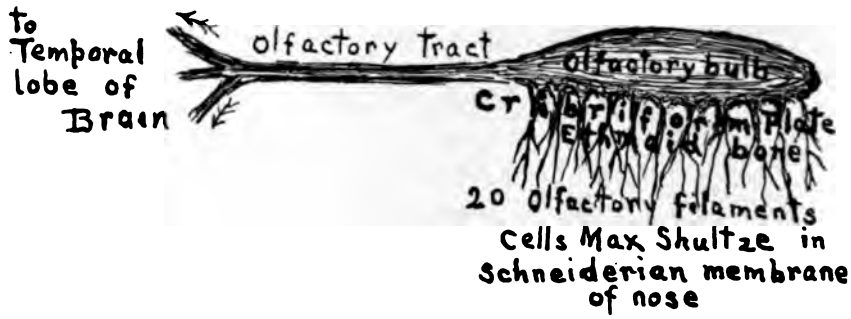

to Temporal lobe of Brain
olfactory tract
olfactory bulb
Cribriform Plate ethmoid bone
20 olfactory filaments
Cells Max Shultze in Schneiderian membrane of nose

FIG. 177.—First Cranial Nerve (Olfactory)

II—Optic nerve
- Origin
  - Superficial
    - Optic commissure and tracts
  - Deep
    - Lateral geniculate, optic thalamus, superior qua[illegible]dri-geminal body
- Exit
  - Optic foramen of Sphenoid
- Description
  - Behind the optic foramen inner fibers decussate and
  - Outer fibers remain on same side, called optic chiasm [illegible]and continues as the optic tract.
  - Travels to nuclei and carried by optic radiations to cu[illegible]eus of occipital lobe
- Function
  - Sight

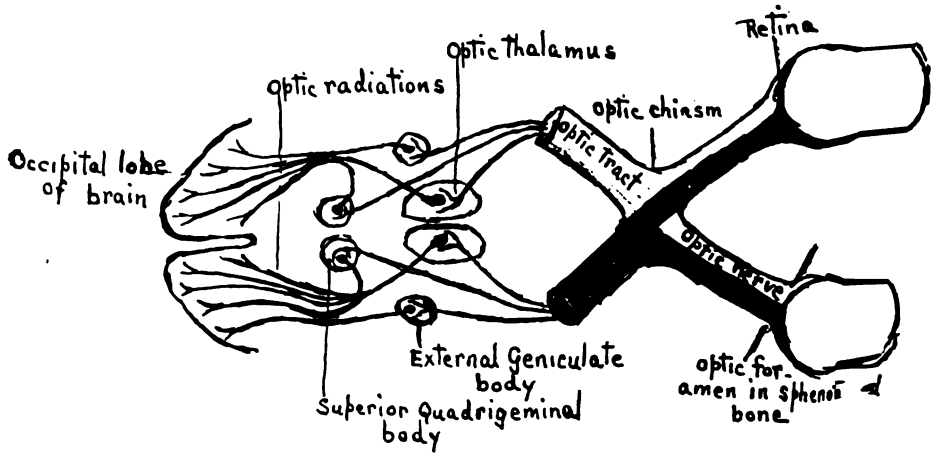


FIG. 178.—Second Cranial Nerve (Optic)

III—Oculi motor

Origin

Superficial

Cerebral peduncles

Deep

Cerebral aqueduct

Exit

Sphenoidal fissure

Distribution

To all eye muscles except superior oblique and lateral Rectus

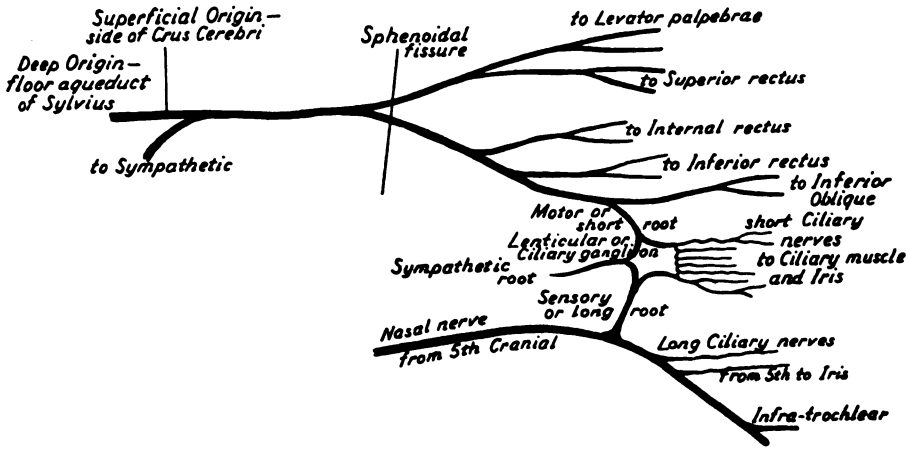


FIG. 179.—Third Cranial Nerve (Motor Oculi)

IV—Trochlear

Origin

Superficial

Cerebral peduncles

Deep

Cerebral aqueduct

Exit

Sphenoidal fissure

Distribution

Superior oblique muscle

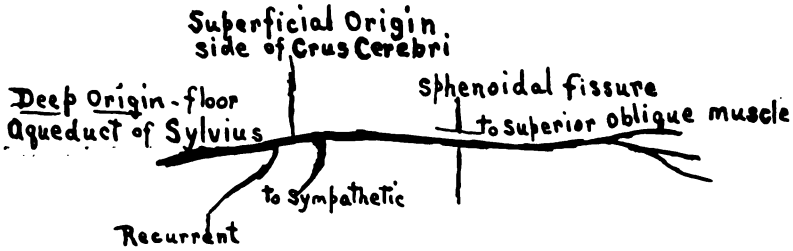


FIG. 180.—Fourth Cranial Nerve (Trochlear)

V—Trigeminal

Origin

A—Nucleus and locus coeruleus in the medulla oblongata for the sensory root

B—Nucleus on the floor of the fourth ventricle and cerebral aqueduct for the motor root

Divisions

Ophthalmic

Leaves skull by sphenoidal fissure and supplies with sensation eyeball, lacrimal gland, conjunctiva and Schneiderian membrane

Maxillary

Leaves skull by foramen rotundum, supplies temple, cheek, eyelid, nose, lip and upper teeth with sensation

Mandibular

Leaves skull by foramen ovale

Motor division

Muscles of mastication

Sensory division

Teeth and gums of lower jaw, skin of temple, external ear, lower face and lips and anterior 2/3 of the tongue

Ganglia

A—Ophthalmic

B—Spheno palatine

C—Otic

D—Submaxillary

E—Semilunar (Gasserian)

VI—Abducens

Origin

Superficial

Pyramid of medulla

Deep

Floor of fourth ventricle

Exit

Sphenoidal fissure

Distribution

Motor to the lateral rectus

VII—Facial

Origin

Has its superficial origin in the upper end of the medulla oblongata in the groove between the olivary and restiform bodies. It passes forward and outward to enter the internal

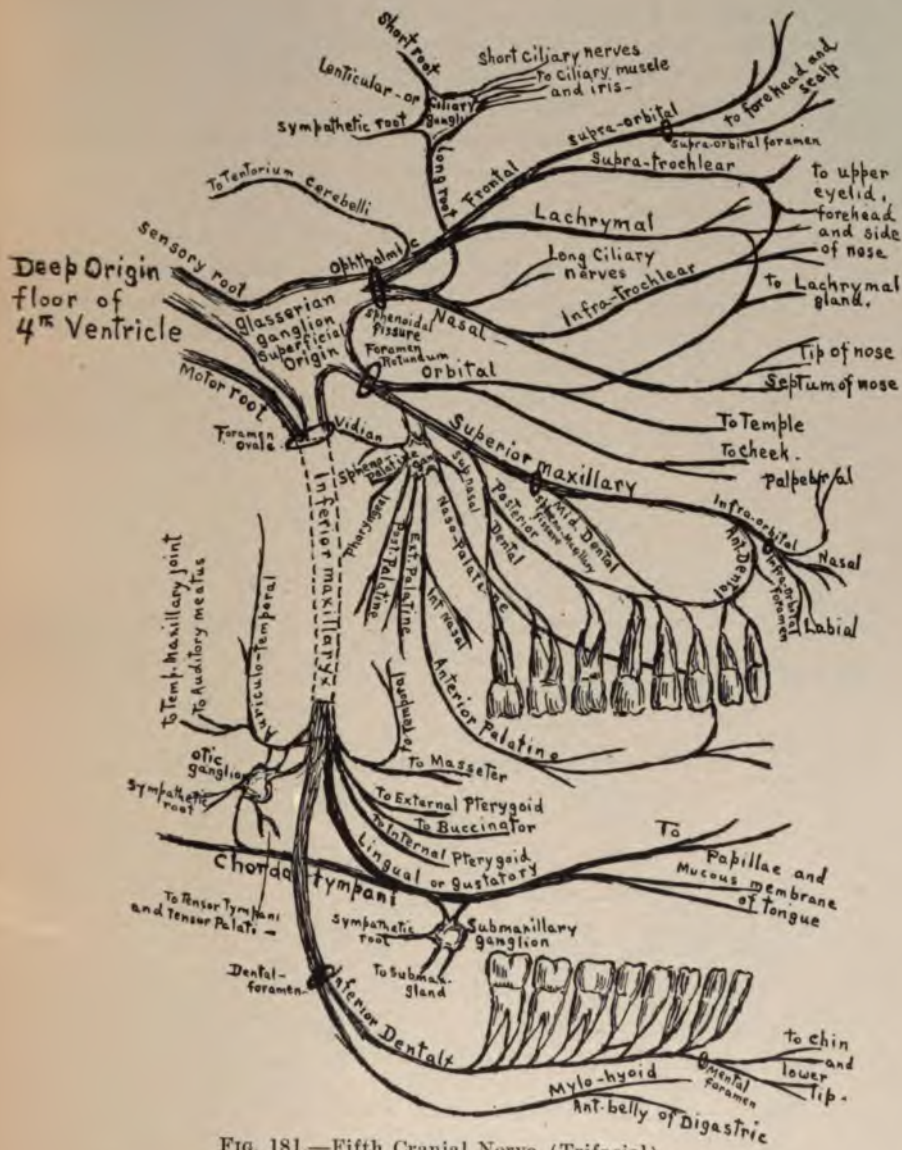


FIG. 181.—Fifth Cranial Nerve (Trifacial)

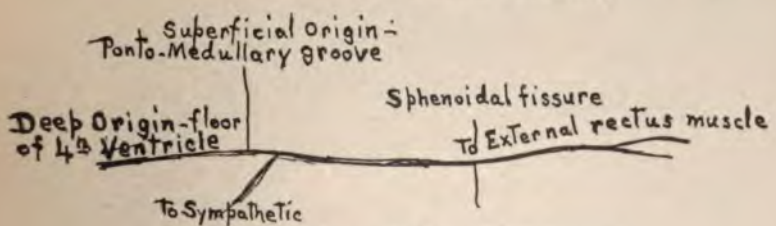


FIG. 182.—Sixth Cranial Nerve (Abducens)

auditory meatus. It lies upon a groove on the auditory nerve, with portio intermedia or Wrisberg and at the bottom of the meatus, it enters the aqueductus Fallopii, along which it runs first outward between cochlea and vestibula as far as the hiatus Fallopii, then backward in the internal wall of tympanum just above the fenestra vestibulae, at the turn presenting a swelling, the geniculate ganglion, and finally it passes downward to emerge from the bone at the stylo-mastoid foramen. It then passes outward and forward in the parotid dividing behind the ramus of the jaw into the tempero facial and cervico facial branches which further subdivide and intercommunicate forming the pes anserinus. Supplies all muscles of expression of face and anterior 2/3 of tongue with taste

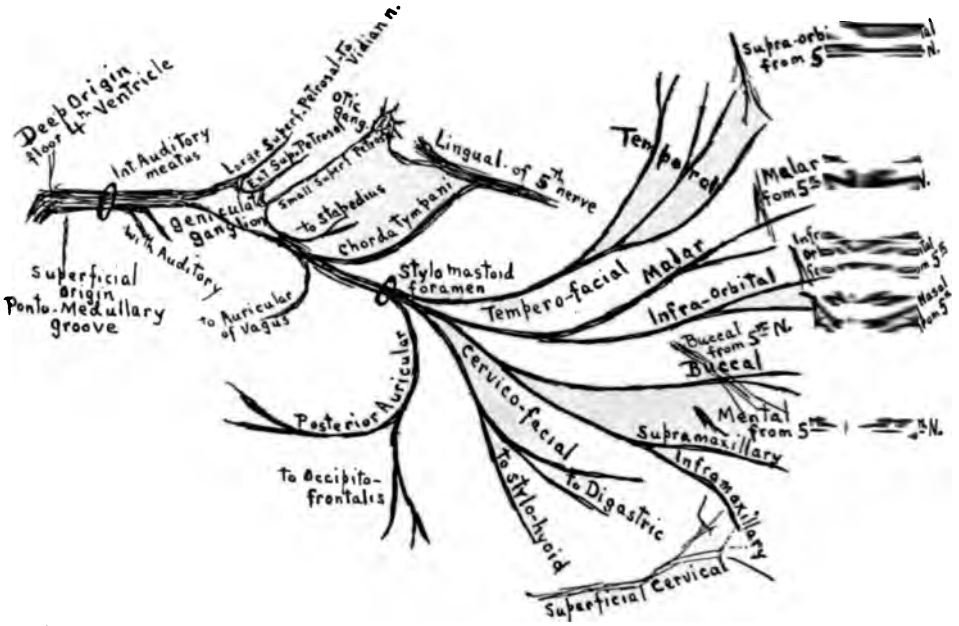


FIG. 183.—Seventh Cranial Nerve (Facial)

VIII—Auditory

Origin

Superficial

Groove between restiform body and seventh nerve

Deep

Floor of the fourth ventricle

Exit

Internal auditory meatus

Distribution
- Cochlear to cochlea for hearing
- Vestibular, to vestibule for equilibration

Ganglion
- Jugular
- Petrous

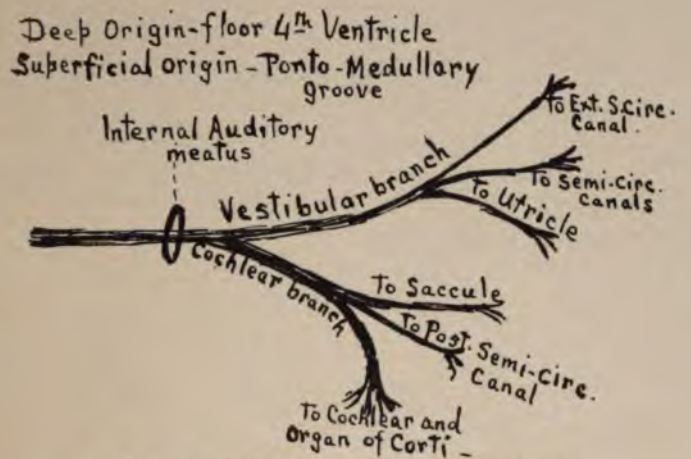


FIG. 184.—Eighth Cranial Nerve (Auditory)

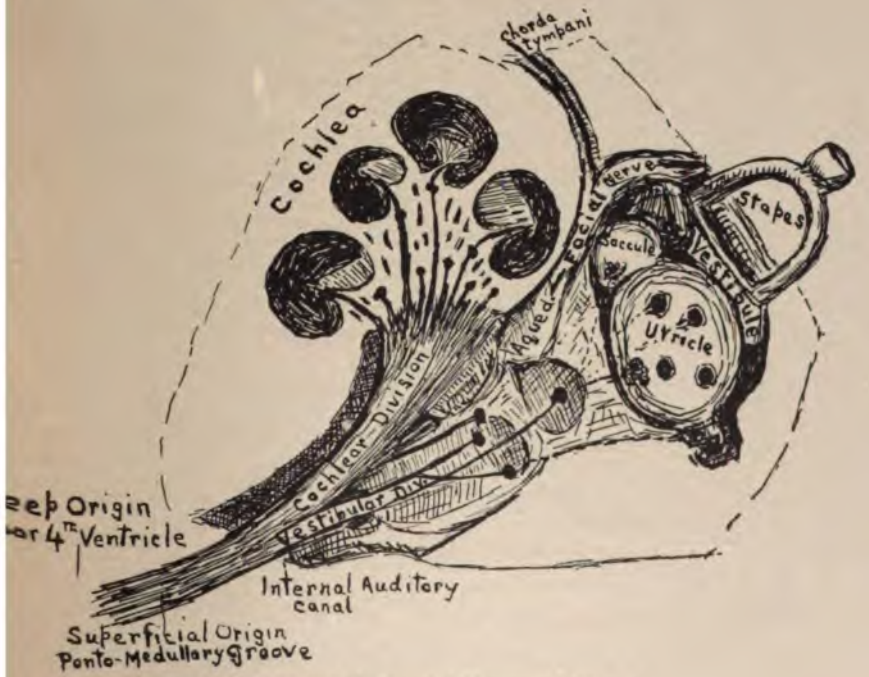


FIG. 185.—Eighth Cranial Nerve (Auditory)

IX—Glosso-pharyngeal
Origin
Superficial
Groove between olivary and restiform body
Deep
Floor of the fourth ventricle
Exit
Jugular foramen
Distribution
Sensory
Mucous membrane of fauces, base of the tongue, glands of mouth and tonsil
Motor
Stylo-pharyngeus
X—Pneumogastric Vagus
Origin
Superficial
Groove between the restiform and olivary bodies
Deep
Nuclei in floor of the fourth ventricle
Course
Outward across the floccula, to jugular foramen through which it passes, here it is joined by the accessory portion of the spinal accessory nerve. As it goes down the neck it lies in front of the rectus capitis anterior major and longus colli muscles. It passes in the carotid sheath behind and between the artery and vein. In the thorax the nerve on each side runs a different course
Right
Passes between the subclavian artery and vein, by side of trachea to root of lung, behind the esophagus, through esophageal opening of the diaphragm to the posterior surface of the stomach
Left
Passes between the subclavian and carotid arteries in front of the arch of the aorta to root of the lung, along anterior surface of esophagus through diaphragm to anterior surface of the stomach
Distribution
Shown by the names of the branches
a—Meningeal
b—Auricular
c—Pharyngeal
d—Superior laryngeal

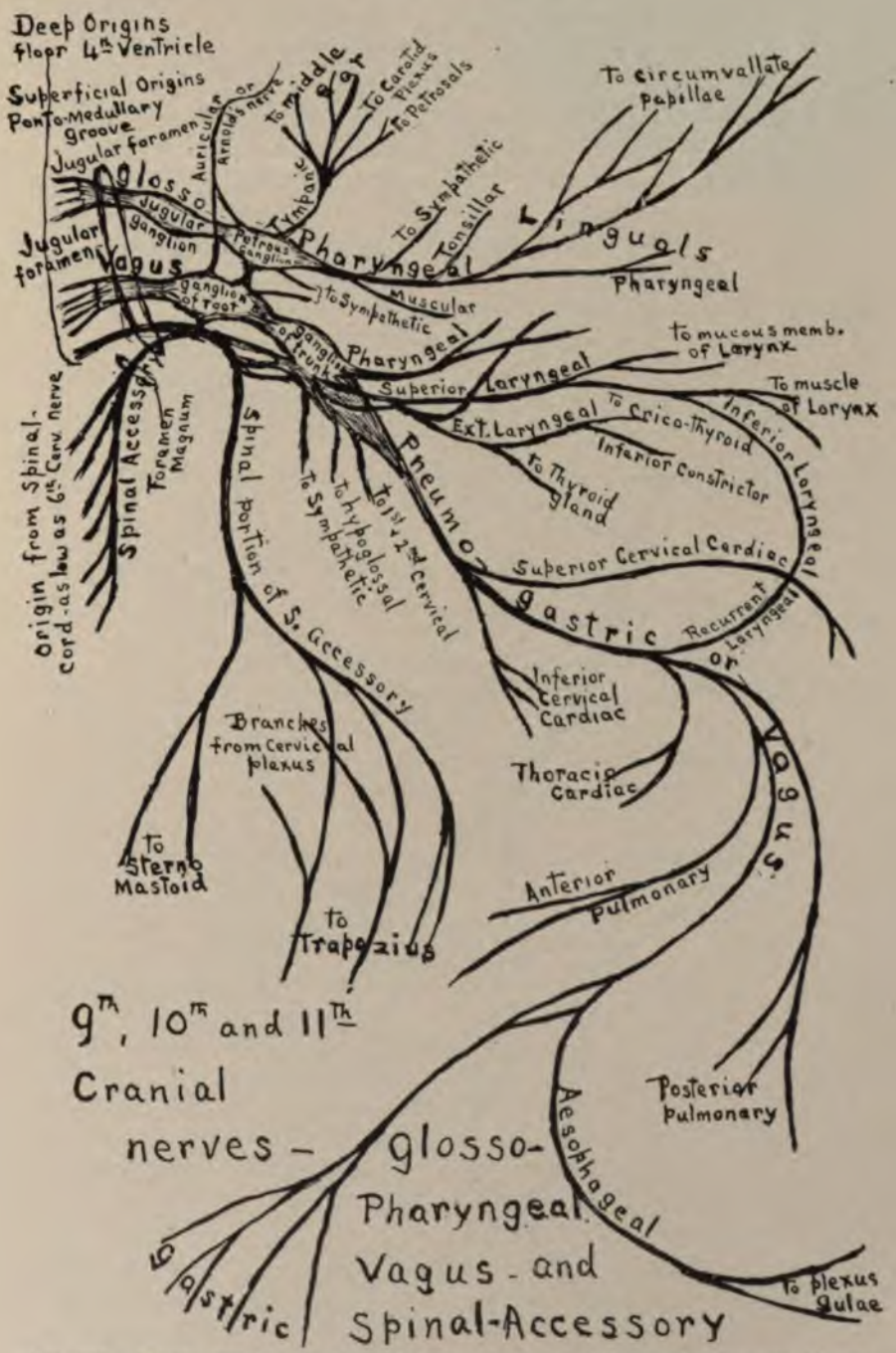


FIG. 186.—Ninth, Tenth and Eleventh Cranial Nerves (Glosso-Pharyngeal) (Vagus and Spinal—Accessory)

e—Inferior laryngeal
f—Cardiac
g—Pulmonary
h—Esophageal
i—Gastric

Function

It supplies:

a—Motor influence to the pharynx and esophagus, stomach and intestines, to the larynx, trachea, bronchi and lungs

b—Sensory and in part

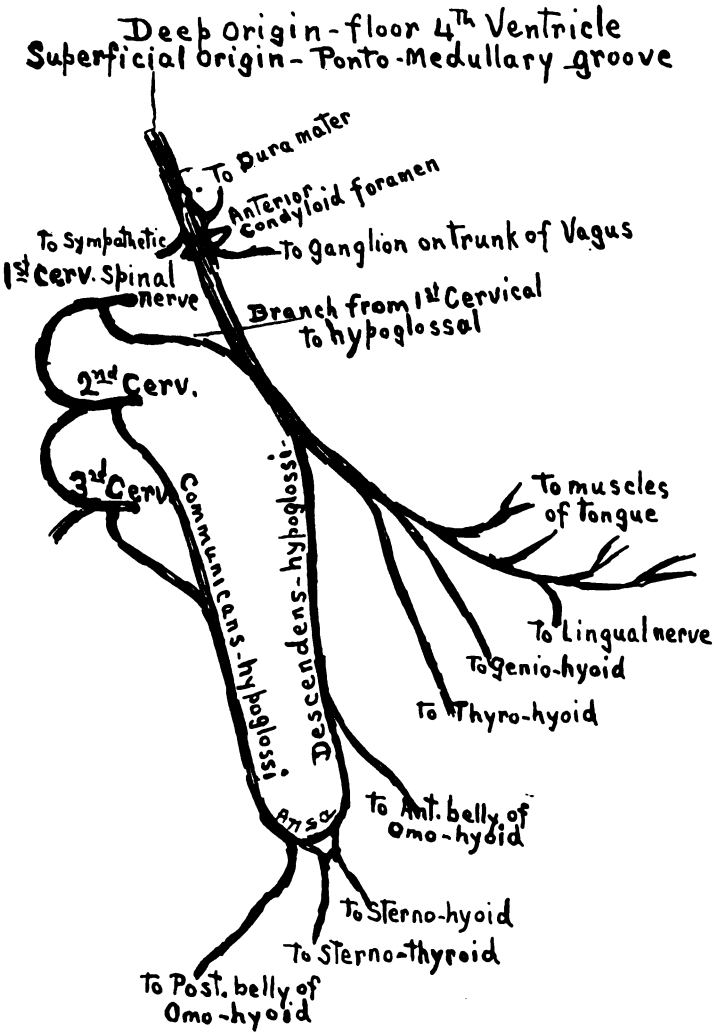


FIG. 187.—Twelfth Cranial Nerve (Hypoglossal)

c—Vasomotor influence, to the same regions
d—Inhibitory influence to the heart
e—Inhibitory afferent impulses to the vasomotor center
f—Excito-secretory to the salivary glands
g—Excito-motor in coughing, vomiting, etc.

XI—Spinal accessory
1—Accessory part
Arises from the floor of the fourth ventricle
Exits by jugular foramen to pharyngeal and laryngeal muscles and muscles of soft palate
2—Spinal part
Arises from lateral tract of the cord and gray matter
Exit
Jugular foramen distributed to sternomastoid and trapezius
Ganglia
Jugular ganglion

XII—Hypoglossal
Origin
Superficial
Groove between pyramid and olivary body
Deep
Fourth ventricle
Exit
Anterior condyloid foramen
Distribution
Muscles of the tongue

SPINAL NERVES

NUMBER

Cervical	8
Dorsal	12
Lumbar	5
Sacral	5
Coccygeal	1
	31

ORIGIN

By two roots; anterior is motor and comes from the anterior horn of cord; posterior root is sensory, has a ganglion upon it and comes from the posterior horn of the spinal cord; anterior and posterior root unite to form spinal nerves which break up into

1—Posterior division

Small, unimportant and supplies muscles and integument of the back

2—Anterior division

Supplies the neck, front and sides of trunk, and extremities unite to form cervical, brachial, lumbar, sacral and coccygeal plexuses

DESCRIPTION

I—Upper fourth cervical

1—Anterior division of upper four cervical forms cervical plexus situated opposite the upper four cervical vertebrae and covered by the sternocleidomastoid

Superficial branches (integumentary)

Ascending set

a—Lesser occipital

b—Great auricular

c—Superficial colli

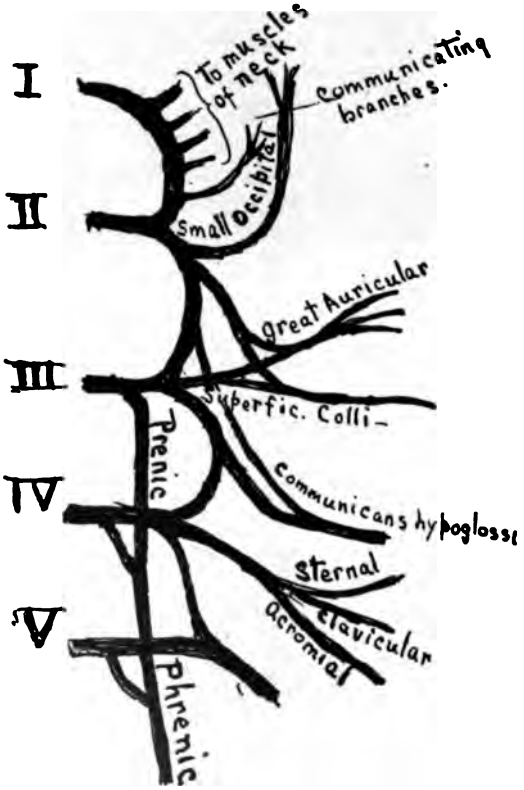


FIG. 188.—Diagram—Cervical Plexus

Descending set
Supra-clavicular branches
Deep branches
A—Communicating
B—Muscular
C—Ansa hypoglossal (communicans noni)
D—Phrenic, most important nerve from this plexus arises from third, fourth and fifth cervicals and distributed to the diaphragm

II—Lower four cervicals
Brachial plexus
A—Formation
Anterior primary division of fifth, sixth, seventh, and eighth cervicals and first dorsal. Fifth and sixth cervicals unite to form upper trunk. Seventh forms the middle trunk, eighth cervical and first dorsal form the lower trunk. All break up into anterior and posterior divisions. Anterior divisions of upper and middle trunk form lateral cord. Anterior division of lower cord forms medial cord and all posterior divisions form posterior cord
a—Outer or lateral cord
1—Lateral anterior thoracic
Pectoralis major
2—External or musculo-cutaneous
A—Sensory
Integument of front of forearm, ball of thumb
Integument of radial side of back of forearm
B—Muscular to all anterior humeral muscles
C—Articular to elbow
3—Median
Forearm
To all anterior radio-ulnar muscles except flexor carpi ulnaris and one-half of flexor digitorum profundus
Hand
Muscular
Abductor pollicis
Oppones pollicis
Flexor pollicis brevis (outer head)
Digital to thumb
Digital to index finger

Sensory
To thumb, index middle and one-half of ring finger palmar surface
4—Muscular
5—Communicating to phrenic
6—Long thoracic to serratus anterior
7—Supra scapular to supra and infra spinatus
b—Medial cord
1—Medial anterior thoracic
Both pectoral muscles
2—Cutaneous antebrachii medialis (internal cutaneous)
Integument of the anterior surface of the inner side of the forearm as low as the wrist; integument of the posterior surface of the inner side of the forearm to near the wrist
3—Cutaneous brachii medialis
(Lesser internal cutaneous)
Integument of the posterior surface of the lower third of the arm
4—Ulnar
Forearm
Articular to elbow joint
Muscular
Flexor carpi ulnaris
Inner half of flexor profundus digitorum
Sensory
To little finger and one-half of ring finger, palmar and dorsal surfaces
c—Posterior cord
1—Subscapular nerves
Upper or lateral
Subscapular muscle
Long or second
Latissimus dorsi
Lower or third
Teres major
2—Axillary
Deltoid
Integument over the shoulder
Teres minor
3—Radial
Muscular

a—Triceps
b—Anconeus
c—Brachioradialis
d—Extensor carpi radialis longus

Cutaneous
a—Integument of the inner and posterior portions and the outer anterior portion of arm
b—Integument of the outer aspect of the forearm

At elbow divides into
a—Superficial ramus (radial)
Sensation to thumb, index, middle and one-half of ring finger on dorsal surface
b—Posterior interosseous
All muscles on back of forearm except
1—Anconeus
2—Brachioradialis
3—Extensor carpi radialis longus
4—Triceps

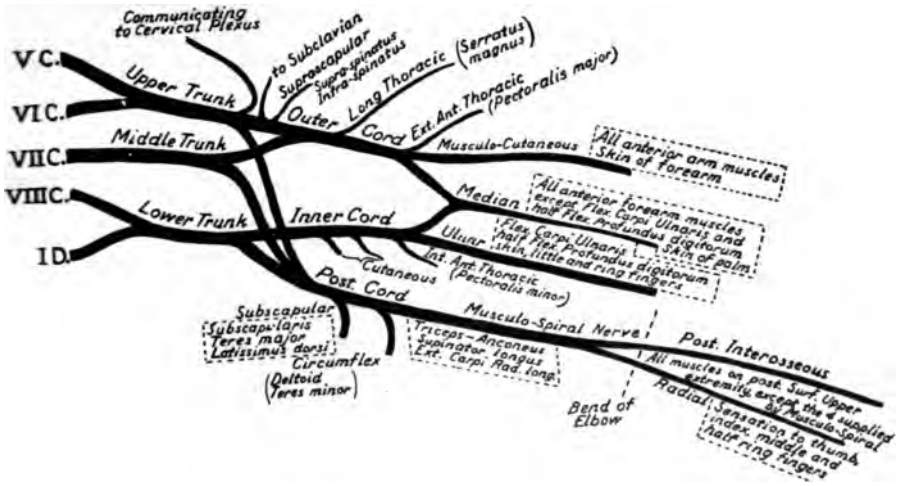


FIG. 189.—Diagram—Brachial Plexus

III—Dorsal nerves

Twelve in number on each side. Anterior divisions called intercostal nerves distributed to walls of the thorax and abdomen. Six upper to parietes of chest. Six lower supply walls of chest

and abdomen. Cutaneous antebrachii dorsalis derived from intercostal given off midway between sternum and vertebra

IV—Lumbar nerves

Formation

First, second, third, and fourth lumbar with communicating branch of fifth lumbar form, the lumbar plexus

Branches

First lumbar

a—Ilio-hypogastric nerve
b—Ilio-inguinal nerve
c—Communicating to second lumbar

Second lumbar

a—Genito-femoral nerve
b—Lateral femoral (external cutaneous)
c—Communicating to third lumbar

Third lumbar

a—Part of femoral nerve
b—Part of obturator nerve
c—Part of accessory obturator nerve
d—Communicating to fourth lumbar

Fourth lumbar

a—Part of femoral nerve
b—Part of obturator nerve
c—Part of accessory obturator nerve
d—Lumbosacral cord

Distribution

A—Ilio-hypogastric

Iliac branch

Integument of gluteal region

Hypogastric

Integument of hypogastric region

B—Ilio-inguinal

a—Internal oblique muscle
b—Integument of upper and inner portion of thigh
c—Integument of scrotum
d—Integument of penis
e—Integument of labium

C—Genito-femoral

External spermatic (genital)

1—Cremaster muscle
2—Scrotum
3—Round ligament of the female

Lumbo inguinal (crural)

1—Integument of the front and upper portion of the thigh

D—Lateral cutaneous femoris (external cutaneous)

Anterior

1—Integument on the anterior and outer aspect of the thigh as low as the knee

Posterior

1—Integument of the posterior and outer aspect of the thigh

E—Femoral

a—Sural

Integument of anterior aspect of thigh as low as the knee

Integument of inner and outer side of knee

Integument of inner side of thigh and leg

b—Muscular

All muscles on front of thigh except the tensor fascia lata

c—Articular

Two in number. Distributed to capsule of knee joint

F—Saphenous nerve

Integument of knee joint and inner sides of leg and foot

G—Obturator nerve

Anterior

Articular

To hip joint

Muscular

To all internal femoral muscles

Posterior

Articular

To knee joint

H—Accessory obturator nerve

Muscular

To pectineus

Articular

To hip joint

Cutaneous

To integument to thigh and leg

V—Sacral nerves

Anterior division of first, second, and third sacral and communicating from fourth sacral, forms sacral plexus

A—Superior gluteal

FIG. 190.—Lumbar Plexus

Superior branch
Gluteus medius
Gluteus minimus
Tensor fascia lata

B—Muscular branches
Gluteal muscles

C—Articular
To hip joint

D—Small sciatic

E—Inferior gluteal branch
Gluteus maximus

F—Pudic nerve
Integument of anal region, scrotum, penis, and labia

Muscular to the muscles of the perineum
Inferior hemorrhoidal
Dorsal nerve of penis
Integument of the penis
Branch to corpora cavernosa

6—Great sciatic

From the lumbosacral cord and first, second and third sacral nerves. After arising from the above nerves, it passes out of the pelvis through the great sciatic foramen below the pyriformis muscle, descends between the great trochanter and the tuberosity of the ischium and passes down the back of the thigh to the lower third, where it divides into the tibial (internal popliteal) and peroneus communis (external popliteal). The nerve sends branches to the hip and knee joints and supplies the flexors of the leg

Branches

1—Articular to hip joint

2—Muscular

All posterior femoral muscles

3—Terminal

Tibial (internal popliteal)
Peroneus communis (external popliteal)

4—Peroneus communis (external popliteal)

A—Articular branches to knee joint
B—Cutaneous branches, supply integument of outer and back part of leg
C—Peroneus profundus (anterior tibial)
Muscular to muscles in front part of leg and to peroneus tertius
Lateral branch
Extensor digitorum brevis
Articular to the tarsus
Medial branch
Integument of adjoining sides of the great and second toes

5—Tibial nerve (internal popliteal)

A—Articular
To knee joint
B—Muscular
Gastrocnemius
Plantaris
Soleus
Popliteus

C—Sural (external saphenous)
Formed by two filaments, one from each of the popliteal nerves
Integument of the outer side of foot and the little toe
D—Posterior tibial nerve
Muscular
Flexor pollicis longus
Flexor digitorum longus
Tibialis posterior
Plantar cutaneous
Integument of heel and inner part of the sole of the foot
Medial plantar
Digital branches
Integument of the three and one-half toes on inner side of foot
Muscular
Flexor digitorum brevis
Abductor Hallucis
Flexor brevis Hallucis
Two inner lumbricals
Articular to tarsus
Cutaneous to sole of foot
Lateral plantar
Muscular
Quadratus plantae
Abductor minimi digiti

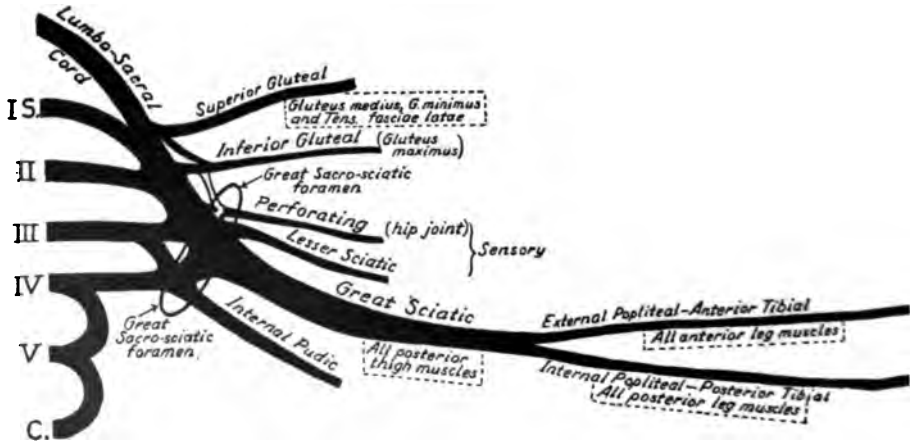


FIG. 191.—Sacral Plexus

Superficial branch
One and one-half outer toes
Flexor minimi digiti brevis
Fourth interosseus muscle
Deep branch
Third and fourth lumbricals
Rest of interossei
Adductor Hallucis
Transversus pedis

SYMPATHETIC NERVES

DEFINITION

System of organic life

CONSIST OF

I—Ganglia
II—Cords of communication
III—Branches of distribution
IV—Plexuses

GANGLIA

I—Cranial
1—Ganglion of Ribes
2—Semilunar ganglion
3—Spheno-palatine (Meckels)
4—Ciliary ganglion
5—Submaxillary ganglion
6—Otic ganglion
II—Cervical
Three in number. First opposite second cervical, second near the inferior thyroid artery, third opposite neck of first rib
III—Prevertebral
Besides the three cervical there are twelve dorsal, five lumbar, five sacral and one coccygeal

PLEXUS

I—Carotid plexus
II—Cavernous plexus
III—Meningeal plexus
IV—Facial plexus
V—Cardiac plexuses
Situated in front of the trachea at its bifurcation above the point of division of the pulmonary artery

VI—Coronary plexus
VII—Solar or epigastric plexus
VIII—Phrenic plexus
IX—Coeliac plexus
Surrounds the coeliac axis and root of the superior mesenteric artery
X—Gastric plexus
XI—Hepatic plexus
XII—Superior mesenteric plexus
XIII—Supra-renal plexus
XIV—Renal plexus
XV—Spermatic plexus
XVI—Aortic plexus
On sides and front of the aorta, between the origin of the superior and inferior mesenteric arteries
XVII—Hypogastric
XVIII—Pelvic plexus
XIX—Auerbach's plexus
Lies between the circular and longitudinal muscle fibers of the intestines
XX—Meissner's plexus
Lies in the submucous coat of the intestines

CORDS OF COMMUNICATION

I—Connecting ganglia of cranium and prevertebral with cranial nerve
II—Those connecting prevertebral with each other forming the two great gangliated cords, united above at the ganglion of Ribes below, at ganglion of Impar
III—Conecting ganglia, with spinal nerves
IV—Connecting prevertebral ganglia with visceral ganglia
V—Those connecting visceral ganglia with each other

BRANCHES OF DISTRIBUTION

I—Superior cardiac to heart
II—Middle cardiac to heart
III—Inferior cardiac to heart
IV—Great splanchnic from sixth to tenth dorsal ganglia to semilunar ganglia
V—Lesser splanchnic from tenth and eleventh dorsal to coeliac plexus
VI—Least splanchnic from twelfth dorsal, terminates in renal plexus

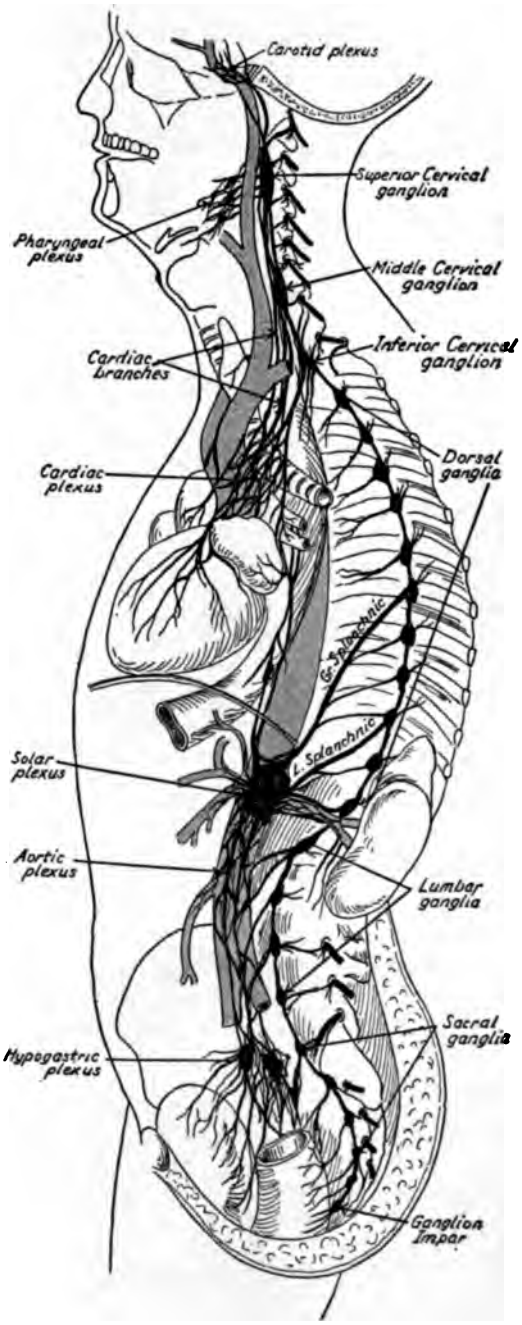


FIG. 192.—Sympathetic Nerve

GLOSSARY

NERVOUS SYSTEM

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
SPINAL MEDULLA	
Fasciculus anterior proprius (Flechsig)	Anterior ground or basis bundle
Fasciculus lateralis proprius	Lateral ground bundle
Nucleus dorsalis	Clarke's column
Pars thoracalis	Dorsal part of spinal medulla
Sulcus intermedius posterior	Paramedian furrow
Columnae anteriores, etc.	Anterior gray horns, etc.
Fasciculus cerebro-spinalis anterior	Direct pyramidal tract
Fasciculus cerebro-spinalis lateralis (pyramidalis)	Crossed pyramidal tract
Fasciculus cerebello-spinalis	Direct cerebellar tract
Fasciculus antero-lateralis superficialis	Gowers' tract

BRAIN

RHOMBENCEPHALON	
Eminentia medialis	Eminentia teres
Ala cinerea	Trigonum vagi
Area acustica	Trigonum accusticum
Nucleus nervi abducentis	Nucleus of sixth nerve
Nuclei n. acustici	Auditory nucleus
Fasciculus longitudinalis medialis	Posterior longitudinal bundle
Corpus trapezoideum	Corpus trapezoides
Incisura cerebelli anterior	Semilunar notch (of cerebellum)
Incisura cerebelli posterior	Marsupial notch
Sulcus horizontalis cerebelli	Great horizontal fissure
Lobulus centralis	Lobus centralis
Folium vermis	Folium cacuminis
Tuber vermis	Tuber valvulae

ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Lobulus quadrangularis	Quadrate lobule
Brachium conjunctivum cerebelli	Superior cerebellar peduncle
Brachium pontis	Middle cerebellar peduncle
Restiform body	Inferior cerebellar peduncle
Lobulus semilunaris superior	Postero-superior lobule
Lobulus semilunars inferior	Postero-inferior lobule
CEREBRUM	
Pedunculus cerebri	Crus cerebri
Colliculus superior	Anterior corpus quadrigeminum
Colliculus inferior	Posterior corpus quadrigeminum
Aqueductus cerebri	Iter e tertio ad quartum ventriculum, or aqued. of Sylvius
Foramen interventriculare	Foramen of Monro
Hypothalamus	Subthalamic region
Sulcus hypothalamicus	Sulcus of Monro
Massa intermedia	Middle commissure
Fasciculus thalamomamillaris	Bundle of Vicq d'Azyr
Pars opercularis	Pars basilaris
Thalamus	Optic thalamus
Pallium	Cortex cerebri
Gyri transitivi	Annectant gyri
Fissura cerebri lateralis	Fissure of Sylvius
Gyrus temporalis superior	First temporal gyrus
Gyrus temporalis medius	Second temporal gyrus
Gyrus temporalis inferior	Third temporal gyrus
Sulcus centralis (Rolandi)	Fissure of Rolando
Sulcus temporalis superior	Parallel sulcus
Sulcu. temporalis medius	Second temporal sulcus
Sulcus circularis	Limiting sulcus of Reil
Sulcus temporalis inferior	Occipito-temporal sulcus
Gyrus fusiformis	Occipito-temporal convolution
Sulcus interparietalis	Intraparietal sulcus
Sulcus corporis callosi	Callosal sulcus
Sulcus cinguli	Calloso-marginal fissure
Fissure hippocampi	Dentate fissure

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Gyrus cinguli	Callosal convolution
Stria terminalis	Taenia semicircularis
Trigonum collaterale	Trigonum ventriculi
Hippocampus	Hippocampus major
Digitationes hippocampi	Pes hippocampi
Fascia dentata hippocampi	Gyrus dentatus
Columna fornicis	Anterior pillar of fornix
Septum pellucidum	Septum lucidum
Cornu inferius	Descending horn of lateral ventricle
Commissura hippocampi	Lyra
Nucleus lentiformis	Lenticular nucleus
Pars frontalis capsulae internae	Anterior limb of internal capsule
Pars occipitalis capsulae internae	Posterior limb of internal capsule
Radiatio occipito thalamica	Optic radiation
Radiatio corporis callosi	Radiation of corpus callosum
Pars frontalis	Forceps minor
Pars occipitalis	Forceps major
MEMBRANES OF BRAIN	
Cisterna cerebello-medullaris	Cisterna magna
Cisterna interpeduncularis	Cisterna basalis
Granulationes arachnoideales	Pacchionian bodies
Tela chorioidea ventriculi tertii	Velum interpositum
Tela chorioidea ventriculi quarti	Tela chorioidea inferior
CEREBRAL NERVES	
N. oculomotorius	Third nerve
N. trochlearis	Fourth nerve
N. trigeminus	Fifth nerve
Ganglion semilunare (Gasseri)	Gasserian ganglion
N. naso-ciliaris	Nasal nerve
N. maxillaris	Superior maxillary nerve
N. meningeus (medius)	Recurrent meningeal nerve

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
N. zygomaticus	Temporo-malar nerve
Rami alveolares, superiores posteriores	Posterior superior dental
Rami alveolares superiores medii	Middle superior dental
Rami alveolares superiores anteriores	Anterior superior dental
Ganglion sphenopalatinum	Meckel's ganglion
N. palatinus medius	External palatine nerve
N. mandibularis	Inferior maxillary nerve
Nervus spinosus	Recurrent nerve
N. alveolaris inferior	Inferior dental
N. abducens	Sixth nerve
N. facialis	Seventh nerve
N. intermedius	Pars intermedia of Wrisberg
N. acusticus	Eighth or auditory nerve
Ganglion superius	Jugular ganglion of ninth nerve
N. recurrens	Recurrent laryngeal nerve
Ganglion jugulare	Ganglion of root of vagus
Ganglion nodosum	Ganglion of trunk of vagus
Plexus esophagus anterior	Plexus gulae
Plexus esophagus posterior	Plexus gulae
Nervus accessorius	Spinal accessory
Ramus internus	Accessory portion of spinal accessory nerve
Ramus externus	Spinal portion
SPINAL NERVES	
Rami posteriores	Posterior primary division
Rami anteriores	Anterior primary divisions
N. cutaneus colli	Transverse superficial cervical nerve
Nn. supraclaviculares anteriores	Suprasternal nerves
Nn. supraclaviculares medii	Supraclavicular nerves
Nn. supraclaviculares posteriores	Supra-acromial nerves
N. dorsalis scapulae	Nerve to the rhomboids
Nn. intercostobrachiales	Intercosto-humeral nerve

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
N. thoracalis longus	Nerve of Bell
N. thoraco-dorsalis	Long subscapular nerve
N. cutaneus brachii medialis	Lesser internal cutaneous nerve
N. cutaneus brachii lateralis	Cutaneous branch of circumflex nerve
Fasciculus medialis	Inner cord
Fasciculus lateralis	Outer cord (of plexus)
N. cutaneus antibrachii lateralis	Cutaneous branch of musculo-cutaneous nerve
N. cutaneus antibrachii medialis	Internal cutaneous nerve
Ramus volaris	Anterior branch
Ramus ulnaris	Posterior branch
N. axillaris	Circumflex nerve
N. interosseus volaris	Anterior interosseous
Ramus palmaris N. mediani	Palmar cutaneous branch of the median nerve
Nn. digitales volares proprii	Collateral palmar digital branches of median nerve
Ramus dorsalis manus	Dorsal cutaneous branch of ulnar nerve
Ramus cutaneus palmaris	Palmar cutaneous branch of ulnar nerve
N. radialis	Musculo-spiral nerve
N. cutaneus brachii posterior	Internal cutaneous branch of musculo-spiral nerve
N. cutaneus antibrachii dorsalis	External cutaneous branches of musculo-spiral nerve
Ramus superficialis	Radial nerve
N. interosseus dorsalis	Posterior interosseous nerve
Nn. digitales dorsales	Dorsal digital nerves
N. ilio-hypogastricus	Ilio-hypogastric nerve
Ramus cutaneus lateralis	Iliac branch of ilio-hypogastric nerve
Ramus cutaneus anterior	Hypogastric branch of ilio-hypogastric nerve
N. genito-femoralis	Genito-crural nerve
N. lumbo-inguinalis	Crural branch of genito-crural nerve
N. spermaticus externus	Genital branch of genito-crural nerve

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
N. cutaneus femoris lateralis	External cutaneous nerve
N. femoralis	Anterior crural nerve
N. saphenus	Long saphenous nerve
Ramus infrapatelaris	Patellar branch of long saphenous nerve
N. ischiadicus	Great sciatic nerve
N. peronaeus communis	External popliteal nerve
Ramus anastomoticus peronaeus	Nervus communicans fibularis
N. peroneus superficialis	Musculo-cutaneous nerve
N. peronaeus profundus	Anterior tibial nerve
N. tibialis	Internal popliteal and posterior tibial nerves
N. cutaneus surae medialis	Nervus communicans tibialis
N. suralis	Short saphenous nerve
N. plantaris medialis	Internal plantar
N. plantaris lateralis	External plantar
N. pudendus	Pudic nerve

SPLANCHNOLOGY

ALIMENTARY APPARATUS

CLASSIFICATION

I—Alimentary canal
- 1—Organs of deglutition
  - A—Mouth
  - B—Pharynx
  - C—Esophagus
- 2—Organs of digestion
  - A—Stomach
  - B—Small intestines
    - Duodenum
    - Jejunum
    - Ilium
  - C—Large intestines
    - Caecum
    - Colon

Rectum

II—Accessory organs

1—Teeth

2—Salivary glands

A—Parotid

B—Submaxillary

C—Sublingual

3—Liver

4—Pancreas

MOUTH

DEFINITION

An oval cavity

Bounded

A—Laterally

By the alveolar processes and the cheeks

B—Above

By the upper teeth and the hard palate

C—Below

By the tongue, mandible (lower jaw) and structures on floor of mouth

D—In front

By the lips

E—Behind

By the glosso palatine arcus (pillars of the fauces), and the soft palate

SHOWS FOR EXAMINATION

I—Tonsil

1—Definition

Two adenoid masses one on either side of the fauces between the glosso-palatine arcus (anterior) and pharyngo-palatine arcus (posterior pillars)

2—Description

Surface of tonsil shows 12–15 recesses called crypts, these crypts are called lymphoid follicles

3—Histology

Surrounded by fibrous capsule, covered with stratified epithelium, which dips into the crypts

4—Arteries

External maxillary (facial)

Lingual

Ascending pharyngeal

5—Nerves
Tonsillar plexus
Ninth cranial
Tenth cranial
Sympathetic

II—Tongue

1—Base
Attached to hyoid bone, epiglottis, soft palate and pharynx

2—Dorsum
Contains three kinds of papillae, filiform on the sides of tongue, fungiform in the center of dorsum. Circumvallate arranged in form of V at the base of the tongue

3—Under surface
Connected with hyoid bone and mandible by the reflection of mucous membrane called fraenum linguae

4—Extrinsic muscles
Styloglossus
Hyoglossus
Geniohyoglossus
Glosso-palatine (palatoglossus)

5—Intrinsic muscles
A—Transverse lingual fibers
B—Superior lingual fibers
C—Inferior lingual fibers
D—Perpendicular lingual fibers

6—Nerve supply
A—Motor
Twelfth cranial
B—Taste
Anterior two-thirds (seventh cranial)
Posterior one-third (ninth cranial)
C—Sensation
Anterior two-thirds (fifth cranial)
Posterior one-third (ninth cranial)

III—Teeth

Temporary, twenty in number, five on each side of jaw, two incisors, one canine, and two molars. Permanent, thirty-two in number, eight on each side of jaw, two incisors, one canine, two premolars (bicuspids) and three molars; each tooth shows for examination, an exposed portion called crown, imbedded portion called the root and between crown and root is the neck.

Eruption of teeth
Deciduous, twenty in number
1—Central incisors, 7th month

2—Lateral incisors, 7th to 10th month
3—Anterior molars, 12th to 14th month
4—Canine, 14th to 20th month
5—Posterior molars, 18th to 30th month

Permanent, thirty-two in number
1—First molars, six and one-half years
2—Two middle incisors, 7th year
3—Two lateral incisors, 8th year
4—First premolars (bicuspids), 9th to 10th year
5—Second premolars (bicuspids), 10th to 11th year
6—Canine, 11th to 12th year
7—Second molars, 12th to 14th year
8—Serotinus (wisdom), 17th to 21st year

Those of the lower jaw generally precede those of the upper by one or two months

IV—Soft Palate
Movable fold of mucous membrane, suspended from the hard palate in the median line shows uvula

V—Hard palate
Formed by the palatal process of the maxilla (superior maxillary) bone and palate bones

VI—Posterior pillars
Formed by the pharyngo-palatine (palato-pharyngeus) muscle

VII—Anterior pillars
Formed by the glosso-palatine (palato-glossus) muscle

SALIVARY GLANDS

A—PAROTID

Largest, from one-half to one ounce in weight, situated in a space bounded below by the angle of the jaw and an imaginary line to the mastoid process, above by the zygoma, in front by the masseter muscle, behind, by the mastoid process. Duct two and one-half inches long, empties opposite the upper second molar,—called Parotid duct (Stenson's duct)

Arteries
External carotid

Nerves
Carotid plexus of sympathetic

B—SUBMAXILLARY

Situated in the submaxillary triangle; duct called submaxillary

(Wharton's) opens beside the fraenum of the tongue; weight two drams

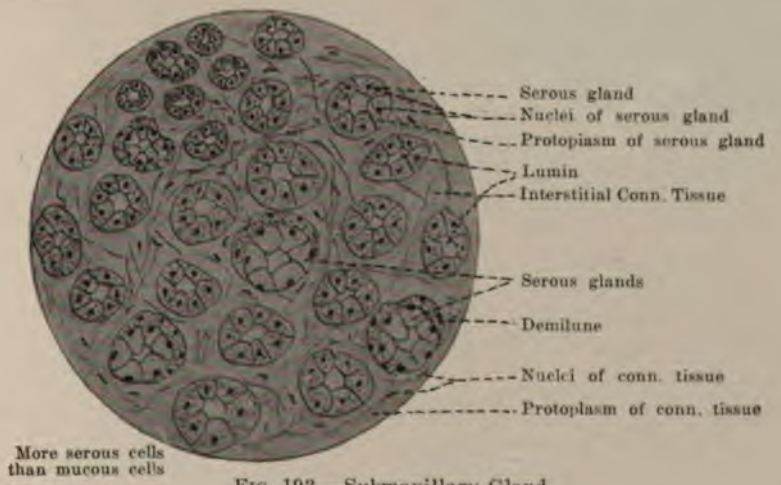


FIG. 193.—Submaxillary Gland

C—SUBLINGUAL

Situated on the floor of the mouth beneath the mucous membrane several little ducts called minor sublingual ducts (Rivini), one, the largest, called sublingual (Bartholin's) duct; weight one-half dram

HISTOLOGY OF SALIVARY GLANDS

I—Composed of racemose glands, surrounded by fibrous capsules which send in trabeculae dividing them into lobes. These lobes are further divided into lobules; the main ducts enter the hilum and divide into interlobar ducts; these form intralobular ducts, which in turn form intermediate tubes which terminate in alveoli

II—All ducts and alveoli lined with a single layer of columnar epithelium

FIG. 194.—Mucous Salivary Gland

FIG. 194a.—Serous Salivary Gland

III—The parotid is a serous gland, the submaxillary a mixed and the sublingual a mucous gland

PHARYNX

DEFINITION

Hollow muscular tube from the base of the skull to the cricoid cartilage in front and the sixth cervical vertebra behind; four and one-half inches long

BOUNDARIES

Above

Petrous portion of the temporal bone and basilar process of the occipital

Behind

Cervical vertebrae and muscles

Below

Continuous with esophagus

Front

Incomplete and is attached to the medial lamina of the pterygoid process (internal pterygoid plate), thyroid and cricoid cartilages

Laterally

Styloid process of the temporal bone, internal carotid artery, ninth, tenth, eleventh and twelfth cranial nerves and sympathetic

Relation

It communicates with the mouth, larynx, nasal cavities, auditory (Eustachian tubes) and esophagus. It is divided into the nasal, oral and laryngeal pharynx, broader transversely than anteroposteriorly. In the nasopharynx is situated the pharyngeal tonsils and the orifices of the Eustachian tubes; the space posterior to the tubes in the lateral wall is called the pharyngeal recess (lateral recess) (Fossa of Rosenmüller), The oropharynx is the portion between the soft palate and superior border of the larynx; it contains the faucial tonsil. The laryngeal pharynx is that portion situated behind the larynx; it contains the sinus pyriformis

Divided for description

1—Nasopharynx, that part behind the nose

2—Oropharynx, that portion behind the mouth

3—Laryngopharynx, that part behind the larynx

Openings

Two posterior nares

Two auditory (Eustachian) tubes
Mouth
Larynx
Esophagus

Coats
1—Inner mucous
Above nares, ciliated columnar epithelium
Below squamous epithelium, three kinds of glands
a—Simple follicular
b—Compound follicular
c—Racemose follicular
2—Middle fibrous
3—Outer muscular

Muscles
Three constrictors, stylopharyngeus and palato-pharyngeus

Arteries
The pharynx is supplied with blood by the following vessels
A—Inferior or ascending palatine artery (branch of the facial)
B—Posterior or descending palatine artery (branch of the internal maxillary)
C—Spheno-palatine artery (branch of the internal maxillary)
D—Pterygo-palatine artery (branch of the internal maxillary)
E—Ascending pharyngeal (branch of the internal carotid)

Nerves
Pharyngeal plexus, formed by the ninth and tenth cranial and sympathetic

ESOPHAGUS

DEFINITION

Musculo-membranous tube from the cricoid cartilage in front and the sixth cervical vertebra behind and extends to ninth dorsal vertebra; ten inches long, one-half to one inch in width; passes through esophageal opening of diaphragm with tenth cranial nerve

HISTOLOGY

I—Mucous membrane, pale, thick, thrown into longitudinal folds; contains compound racemose glands
II—Submucous coat, loose connective tissue
III—Muscular (longitudinal and circular set of muscles)

VESSELS

Thoracic aorta

NERVES

Tenth cranial nerve, vagus and sympathetics

RELATION

Esophagus extends from the cricoid cartilage to the cardiac end of the stomach. In the neck it lies between the trachea and the vertebral column and longus colli muscle; in the lower part of the neck it inclines to the left, having on each side the common carotid artery and the lateral lobe of the thyroid gland. The recurrent laryngeal nerves ascend between the esophagus and the trachea. In the thorax the esophagus is at first slightly to the left; after passing posterior to the aortic arch it descends in the posterior mediastinum along the right side of the aorta to the diaphragm where it passes in front previous to entering the abdomen

STOMACH

DEFINITION

Hollow muscular organ, situated in the left hypochondriac, epigastric, and part of right hypochondriac regions

RELATIONS

I—Anterior surface in relation to the under surface of the liver, diaphragm and anterior wall of abdomen

II—Posterior surface, covered by peritoneum

III—Splenic end or fundus, connected to the spleen by gastro splenic omentum

IV—Pyloric end, in relation to the wall of the abdomen, under surface of liver and neck of gall bladder

V—Greater curvature, in relation to the colon and gives attachment to gastro colic or greater omentum

VI—Lesser curvature connected to the diaphragm by the gastro phrenic ligament and to the liver by the gastro hepatic or lesser omentum

VII—Esophageal or cardiac opening, corresponds to ninth dorsal vertebra

FORMS

Conical, with fundus to the left side; upper border concave, called lesser curvature; lower border convex, called greater curvature

DIMENSIONS

Length, ten to twelve inches

Width, four to five inches
Weight, four and one-half ounces

LIGAMENTS

I—Left or cardiac end, fixed by the esophagus to the diaphragm, connected to the spleen by the gastro splenic omentum
II—Superior border attached to the liver by the lesser omentum
III—Inferior border attached to the colon by the greater omentum

HISTOLOGY

I—Mucous coat, honey-combed, called rugae, due to depressions for glands
1—Peptic glands, near the cardiac extremity, consist of tubes lined by columnar epithelium of which there are two layers of cells, the outer called the parietal, the inner called the central
2—Pyloric glands, single layer of cells

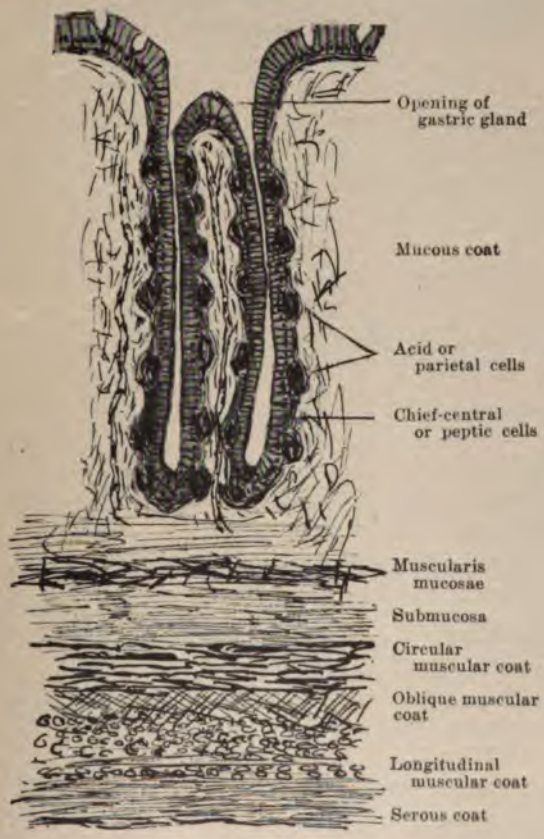


FIG. 195.—Cardiac End of Stomach

II—Submucous
Loose connective tissue, contains the blood vessels
III—Muscular
Three layers, longitudinal, oblique and circular
IV—Serous coat
Visceral layers of peritoneum

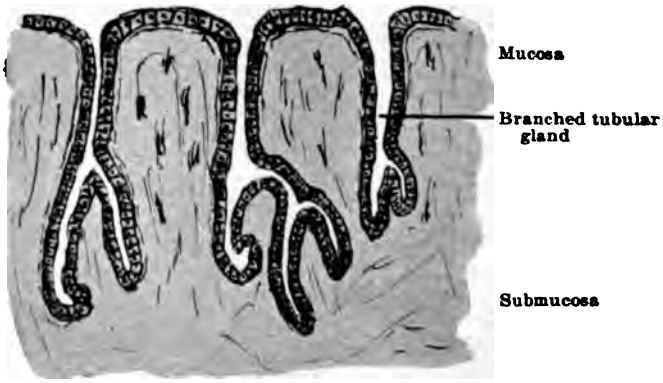


FIG. 196.—Pyloric End of Stomach

ARTERIES

Coronary and pyloric along upper curvature; gastro-epiploica dextra and sinestra along inferior curvature; vasa brevia from splenic artery to the walls of the stomach

NERVES

Right vagus to posterior surface
Left vagus to anterior surface

INTESTINAL CANAL

CLASSIFICATION

Small intestine
1—Duodenum
2—Jejunum
3—Ileum
Large intestine
1—Cecum
2—Colon
A—Ascending colon
B—Transverse colon
C—Descending colon
D—Sigmoid flexure
3—Rectum

A—*DUODENUM*

- Length, eight to ten inches long
- Shape
  - Horse shoe, convexity to the right side, concavity encloses head of the pancreas
- Position
  - In right hypochondriac and epigastric regions
- Divisions
  - Ascending part
    - Freely movable, two inches long, directed from the pylorus to the gall bladder
      - Relations
        - In front
          - Liver and gall bladder
        - Behind
          - Bile ducts
          - Portal vein
          - Hepatic artery
  - Descending part
    - Firmly fixed, three inches long, passes from the gall bladder to the third lumbar vertebra, in front of right kidney. Ducts of liver and pancreas enter this part
      - Relations
        - In front
          - Hepatic flexure of colon
        - Behind
          - Right kidney
        - Inner side
          - Head of pancreas, common bile duct
  - Transverse part
    - Longest and narrowest, five inches long, passes across spine from third to second lumbar vertebra
- Special characteristics
  - 1—Largest part
  - 2—Thickest coats
  - 3—Duodenal glands (Brunner's glands)
  - 4—Plica circulares (valvulae conniventes)
  - 5—No mesentery
- Nerve
  - Solar plexus
- Arteries
  - Pyloric, pancreatico duodenal, of hepatic, inferior pancreatico duodenal, of superior mesenteric

B—JEJUNUM

Extends from the left of the second lumbar vertebra, length two-fifths of small intestine

1—More vascular than ileum

2—Plica circulares (valvulae conniventes) not present

3—Villi well marked

C—ILEUM

Three-fifths of balance of intestine

1—Villi small

2—Plica circulares (valvulae conniventes) not present

3—Aggregation of lymphatic nodules (Peyer's patches) present

Coats

Small intestine consists of four coats

1—Serous peritoneal

2—Muscular

Inner circular and outer longitudinal fibers

3—Submucous coat

Blood vessels, nerves and lymphatics held together by connective tissue

4—Mucous

Inner coat lined by a layer of columnar epithelium shows

a—Plica circulares (valvulae conniventes) crescentic reduplications of the mucous and submucous coat extending into the intestine for about two-thirds of its circumference. They begin about two inches below the pyloric orifice of the stomach and are largest and most numerous immediately below the opening of the pancreatic duct and in the middle of the jejunum, while they nearly disappear in the lower part of the ileum

b—Villi, minute projections on the mucous membrane, about one thirty-fifth of an inch in height. They are conical, cylindrical or club-shaped and are most numerous in the upper part of the small intestine

c—Glands of intestines (glands or crypts of Lieberkühn), minute tubular depressions found all over the small intestine and even in the large intestine and stomach. They are lined with columnar epithelium

d—Solitary lymphatic nodules (solitary glands) which are most abundant in the lower part of the small intestine and which are usually situated upon the

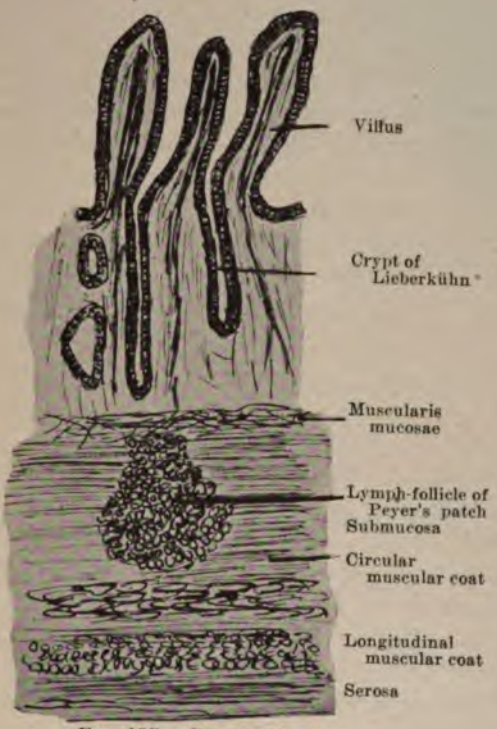


FIG. 197.—Small Intestine

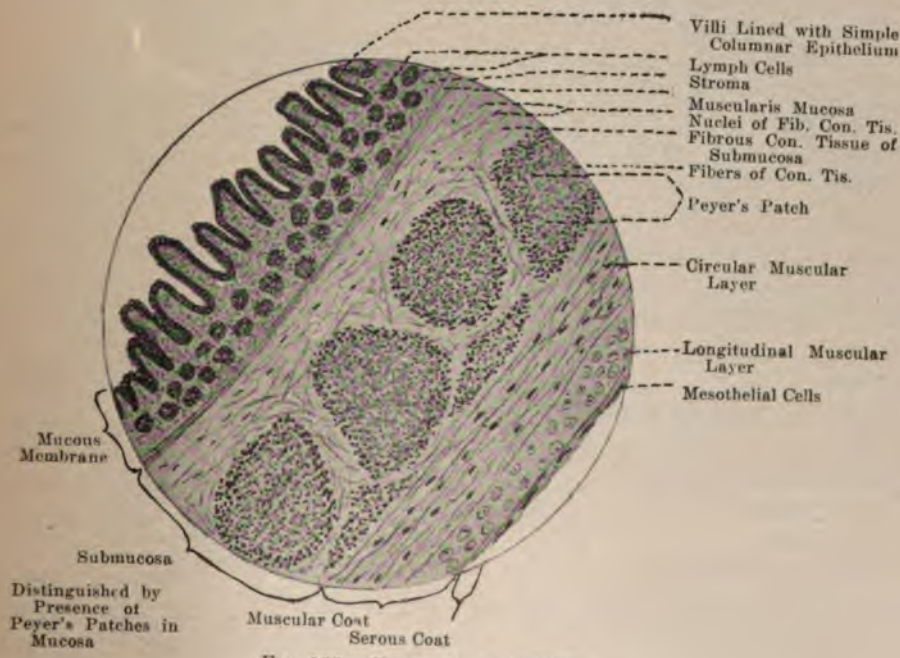


FIG. 198.—Ileum, Cross Section

free margins of that tube, at a point most distant from its border of attachment

c—Aggregation of lymphatic nodules (Peyer's patches), which are glands arranged in groups along the course of the intestine. The total number of these patches varies from twenty to thirty and are found only in the ileum

f—Duodenal glands (Brunner's glands), which are small conglomerate glands, exist chiefly in the duodenum and commencement of the jejunum

LARGE INTESTINE

EXTENT

From ileum to anus, five feet

CHARACTERISTICS

I—It is only about one-quarter of the length of the small intestine

II—It is sacculated, while the small intestine is not

III—Much larger in its diameter

IV—Much less movable, being attached for the greater portion of its length closely to the parietes of the abdomen and parts to which it bears relation

V—The circular plica (valvulae conniventes) are indistinct and in some places absent

VI—The villi are either absent or are few in number

VII—Duodenal glands (glands of Brunner) are absent

VIII—Solitary lymphatic nodules (solitary glands) and Peyer's patches are absent, excepting at its upper portion

IX—Glands of intestine (tubular glands of Lieberkühn) are larger and more numerous than in the small intestine

X—Its longitudinal muscular layers are arranged as three distinct bands, while in the small intestines they are evenly distributed over its entire circumference

XI—Serous covering of the large intestine does not completely surround it in all of its portions, and form pouches called appendices epiploica

DIVISIONS

Cecum

Colon

Ascending

Transverse

Descending

Rectum

I—Cecum

First division of the large intestine ("cul de sac"), two and one-half inches in length, same in width, in right iliac fossa; held in place by the meso-cecum; presents a tubular projection called the appendix

Vermiform Appendix

A small blind tube, generally hollow to its tip, its lumen continuous with that of the cecum and sometimes guarded by a valve

Length

Three and three-fourths inches

Diameter

One-fourth inch at base

Three-sixteenths inch at apex

Origin

Generally arises, about three-fourths inch below, ileo-cecal valve, upon its inner and posterior aspect; but sometimes forms the true apex of the cecum

Course

Variable

The appendix generally passes upward from behind the caecum toward the spleen, lying behind lower end of the ileum and its mesentery

Relations to peritoneum

Mesentery always present but not extending to the tip about distal third, being entirely enveloped in peritoneum and free. Meso-appendix, of triangular form —derived from left leaf of mesentery—containing in its free margin, posterior branch of ileo-cecal artery (from ileo-colic)

Relations to cecum

Four types

1—Appendix arising from apex of cecum

2—Appendix arising between two sacculi of equal size

3—Appendix arising between two sacculi of unequal size (about 90% of cases)

4—Appendix appearing to arise from ileo-colic junction

Relations to anterior abdominal wall

McBurney

Draw a straight line from the antero-superior iliac spine to the umbilicus, and beneath this line,

from 1½ to 2 inches internal to the spine, the base of the appendix is found (in right iliac fossa)

II—Colon

Divided into

A—Ascending

B—Transverse

C—Descending

D—Sigmoid flexure

Ascending colon

Extends from the cecum to the under surface of the liver to the right of the gall-bladder, where it turns to the left, forming the Hepatic Flexure. It lies in the right iliac and right hypochondriac regions. The peritoneum covers the anterior and lateral surfaces. Length.....Eight inches

Transverse colon

Passes from right to left from the gall-bladder to the spleen. It forms an arch, convex anteriorly and below (the transverse arch of the colon). It is entirely surrounded by peritoneum, which is attached posteriorly to the spine, forming the mesocolon. Length.....Twenty inches

Descending Colon

Passes from the end of the transverse colon by a Bend (the splenic flexure). Between the splenic flexure and the diaphragm, opposite the tenth left rib, is a fold of the peritoneum, the costocolic ligament, which slings up the spleen. The gut then passes downward to the sigmoid flexure. The peritoneum invests its anterior and lateral surfaces. Length.....Four to six inches

Sigmoid flexure

1—Iliac portion

Continuous with the descending colon at the left iliac crest and ends at the inner border of the left psoas. Peritoneum invests its anterior and lateral surfaces; it has no mesentery. Length.....Five to six inches

2—Pelvic portion

Extends from the inner border of the psoas to the level of the third sacral vertebra. Length.....16–17 inches, very variable

It has an extensive mesentery

III—Rectum

Terminal part of the large intestine, extends from the sigmoid flexure to the anus, six to eight inches in length; begins opposite the left sacro-iliac synchondrosis to the third piece of sacrum, divided into three parts

First part

Extends from the left sacro-iliac synchondrosis to the middle of 3rd piece of sacrum, completely surrounded by the peritoneum; attached to sacrum by meso-rectum

Relations

Behind

Pyriformis

Sacral plexus

Left hypogastric (internal iliac artery)

Front

Posterior surface of bladder and uterus

Second part

From third piece of sacrum to tip of coccyx

Relation

Front

Base of bladder, vesiculae seminales prostate, and in female, the vagina

Third part

Extends from the tip of the coccyx to the anus; has no peritoneum

Relations

Front

Prostate, urethra, in female the vagina

Structure of large intestine

1—Mucous membrane

Smooth, lacks villi; lined by a single layer of columnar epithelium

2—Submucous

Loose fibrous tissue; contains blood vessels

3—Muscular

Inner circular, outer longitudinal coats

4—Serous

Peritoneal coat

Nerves

In muscular coat Auerbach's plexus. In the submucous coat Meissner's plexus

Blood supply of the intestines

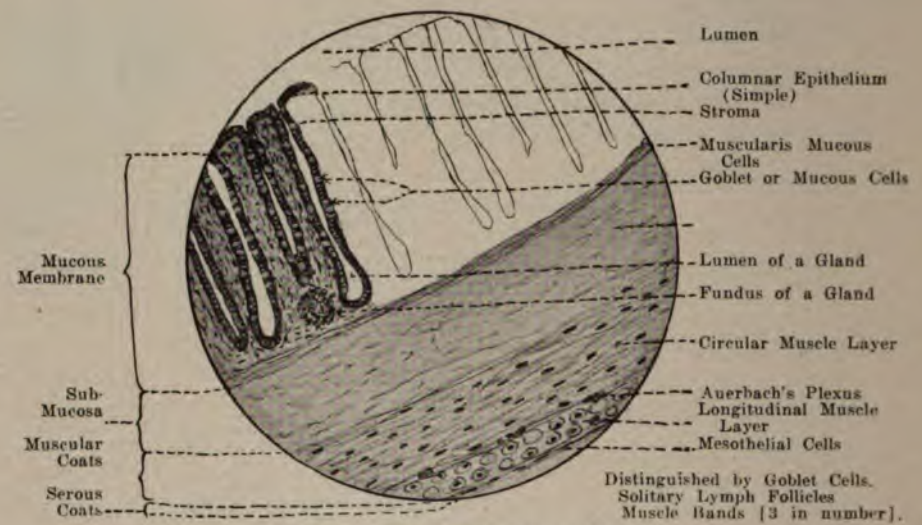


FIG. 199.—Large Intestine Cross Section

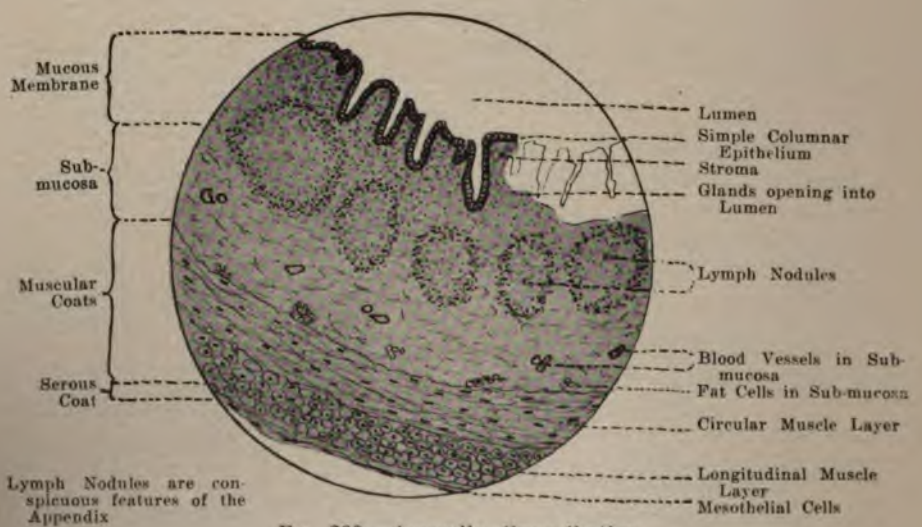


FIG. 200.—Appendix, Cross Section

Duodenum

Pyloric and pancreatico-duodenal (of the hepatic) and inferior pancreatico-duodenal (of superior mesenteric)

Jejunum and Ileum

Branches of the superior mesenteric artery

Cecum and appendix

Ileocolic and appendicular arteries

Colon

Right colic and middle colic (of superior mesenteric), left colic and sigmoid branches (of inferior mesenteric)

Rectum

Superior hemorrhoidal (of inferior mesenteric), middle hemorrhoidal (from internal iliac) and inferior hemorrhoidal (from internal pudic artery)

E—PERITONEUM

Definition

Serous membrane which lines the abdominal cavity and invests the viscera

Reflexions

1—Omenta are folds of peritoneum that connect the stomach to adjoining organs

A—Gastro-hepatic or lesser omentum

B—Gastro-colic or greater omentum

Consists of four layers; most anterior and posterior layers belong to the great peritoneal cavity and two internal, belong to the lesser cavity

2—Mesentery is a process of peritoneum that connects a part of the intestine to the abdominal wall

A—Meso-cecum

B—Meso-colon

C—Meso-rectum

Extends from the left side of the second lumbar vertebra to the right sacro-iliac synchondrosis, a space of six inches; anterior extremity twenty-five feet long, breadth four inches, contains arteries, veins and lacteals

3—Ligament, a process of peritoneum that connects an organ, solid or hollow (except stomach or intestine), to adjacent parts

A—Stomach one ligament

B—Liver four ligaments

C—Bladder five ligaments

D—Uterus six ligaments

E—Spleen one ligament

Description

Composed of two layers; parietal covers abdominal wall and visceral covers viscera

Parts covered by peritoneum

1—Liver (almost entirely)

2—Spleen

3—Duodenum, ascending portion

4—Jejunum
5—Ileum
6—Transverse arch of colon
7—Sigmoid flexure of colon
8—Upper third of rectum
9—Ovaries
10—Posterior portion of bladder
11—Uterus

Partially covered by peritoneum
Duodenum, descending and transverse portions
Colon, ascending and descending portions
Rectum, middle portion
Vagina, upper part

No covering of peritoneum
Rectum, lower part
Bladder, lower part, neck and anterior surface

Tracing the peritoneum
1—Course of greater sac in longitudinal section

Passing down from the umbilicus, the peritoneum lines the anterior abdominal wall, covers the urachus and obliterated hypogastric arteries, passes on to the bladder, from its upper aspect to the trigone, is reflected on to the anterior and upper part of the lateral aspects of the rectum in the male, forming the recto-vesical pouch. In the female, the reflexion is from the bladder on to the uterus (utero-vesical fold), extending thence over the upper portion of the posterior vaginal wall, and thence to the rectum (recto-vaginal pouch). From the rectum, the sigmoid flexure of the colon is entirely covered (sigmoid mesocolon); the ascending and descending colons being covered, generally only anteriorly and laterally and passing from the spine downward; the peritoneum covers the small intestines, forming the lower leaf of the mesentery—and thence back again, completing the investment of the small bowel forming the upper leaf of the mesentery and passes backward over the transverse portion of the duodenum to the pancreas, thence forward to form the inferior layer of the transverse mesocolon; covers the inferior and part of the anterior aspect of the transverse colon, thence runs downward to form the posterior layer of the great omentum; thence to the stomach, covering its antero-superior aspect, thence to the under surface of the liver, forming the anterior layer of the lesser or gastro-hepatic omentum; thence covers the inferior surface of the liver; from the transverse fissure to its anterior

border whence it is reflected over the anterior border to cover the superior surface of the liver, to the posterior peritoneal limit it passes to the inferior concave surface of the diaphragm (superior layer of the coronary ligament), thence over the anterior portion of the concavity of the diaphragm to the anterior abdominal wall, whence it passes down the anterior abdominal parietes to the umbilicus to the place of beginning

2—Course of the lesser sac of the peritoneum

Forming the lesser sac in longitudinal section. Beginning at the posterior aspect of the stomach which it covers, the peritoneum of the lesser sac passes upward to the interior surface of the liver behind the transverse fissure, forming the posterior layer of the lesser or gastro-hepatic omentum and having covered the postero-inferior

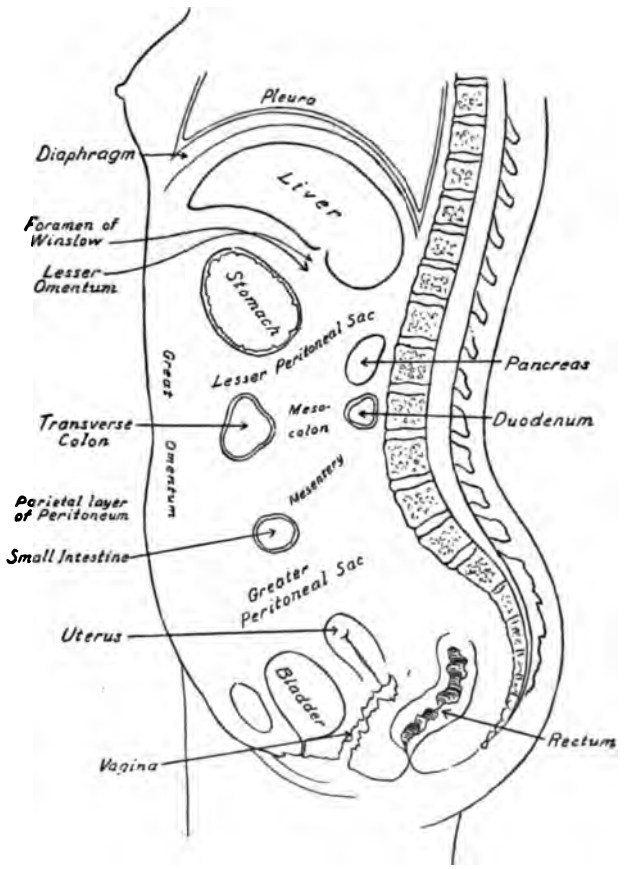


FIG. 201.—Diagram of Peritoneum

aspect of the liver, it passes on to the under surface of the diaphragm (inferior layer of the coronary ligament), thence passes downward over the posterior portion of the concavity of the diaphragm to the spine, covering the great vessels, thence to the pancreas, thence forward, forming the upper layer of the transverse mesocolon, covers the supero-anterior aspect of the transverse colon, descends, forming the innermost layer of the great omentum, then ascends to the greater curvature of the stomach, and covers its posterior wall, to the place of beginning. The lesser sac is in rela-

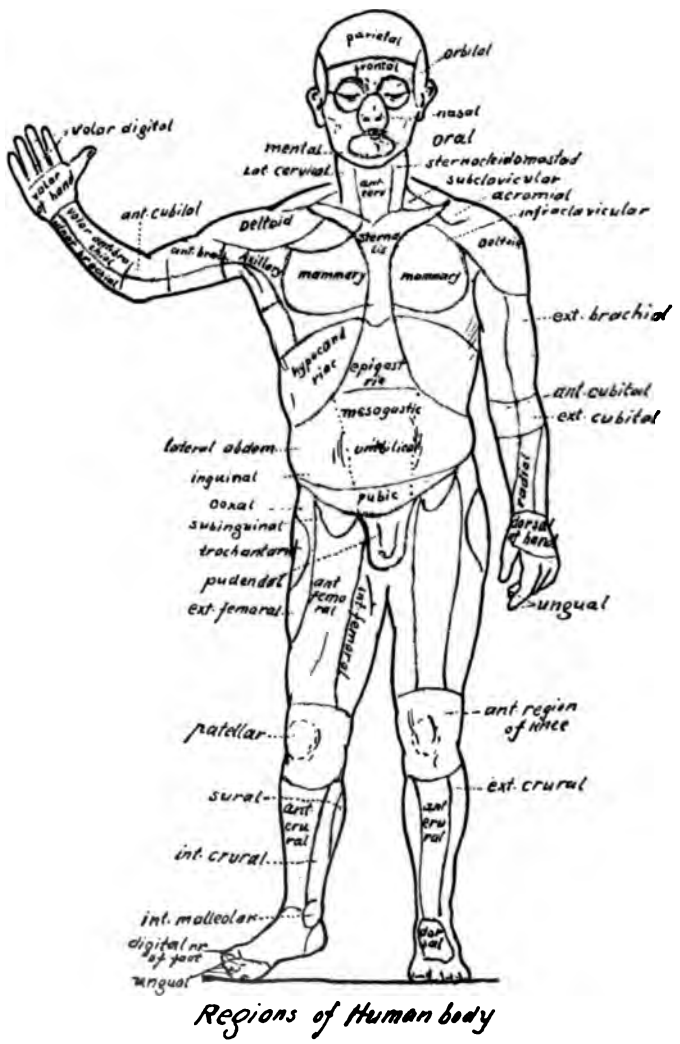
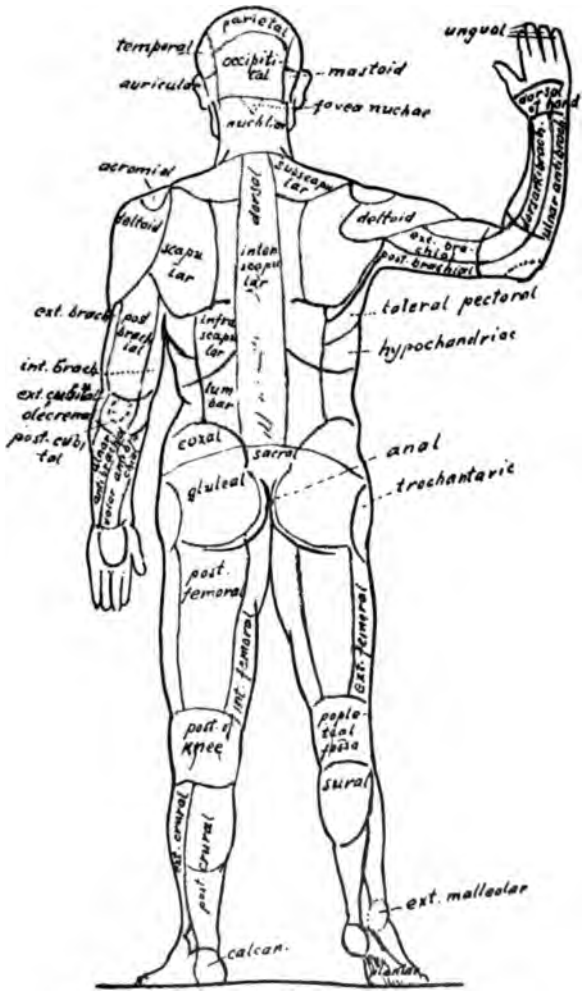


FIG. 202.—Regions of the Human Body (Anterior View)

tion with the inner aspect of the spleen, forming the inner layer of the gastrosplenic omentum, and also in relation with the superior portion of the left kidney

F—REGIONS OF ABDOMEN

Divided into nine areas by four lines, two vertical lines extend from the middle of inguinal (Poupart's) ligament to cartilage of 9th rib. The upper horizontal passes through cartilages of the 9th rib. The lower horizontal across the highest point of the crest of the Ilium. Parts contained in region



Regions of Human body

FIG. 203.—Regions of the Human Body (Posterior View)

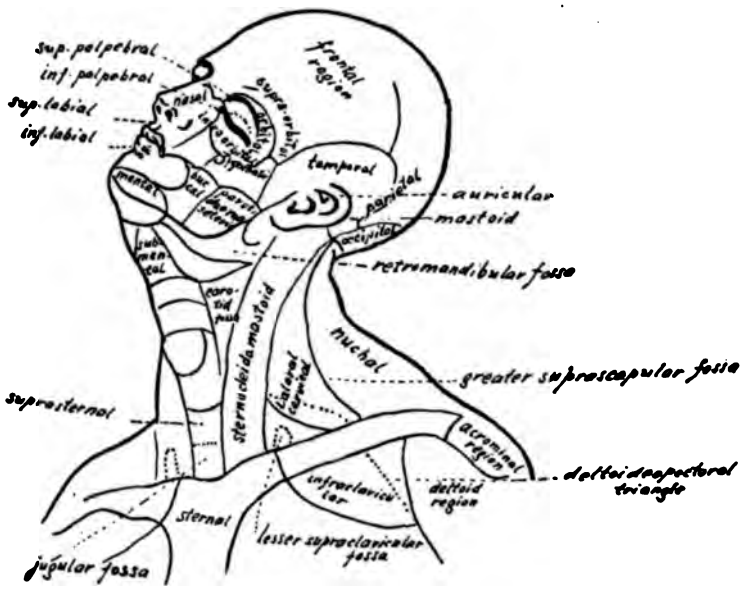


FIG. 204.—Regions of the Head and Neck

Right hypochondriac
- A—Ascending part of duodenum
- B—Hepatic flexure of colon
- C—Right lobe of liver
- D—Gall bladder
- E—Upper half of right kidney and its capsule

Left hypochondriac
- A—Cardiac end of stomach
- B—Splenic flexure of colon
- C—Left lobe of liver
- D—Spleen
- E—Upper half of left kidney and its capsule

Right lumbar
- Descending part of duodenum
- Lower half of right kidney
- Convolutions of small intestine
- Head of pancreas
- Ascending colon

Left lumbar
- A—Descending colon
- B—Lower half of left kidney
- C—Convolutions of small intestine

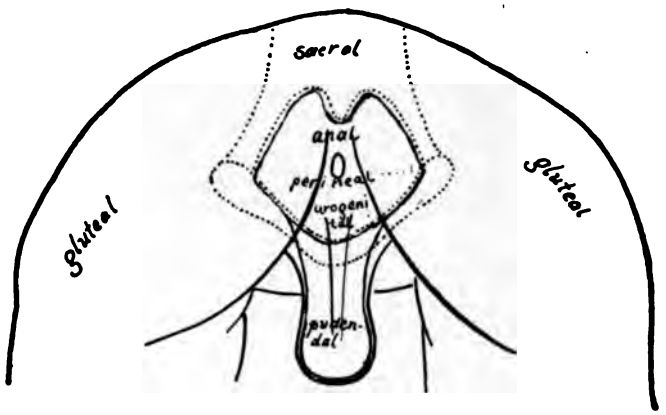


FIG. 205.—Regions of Male Peroneum

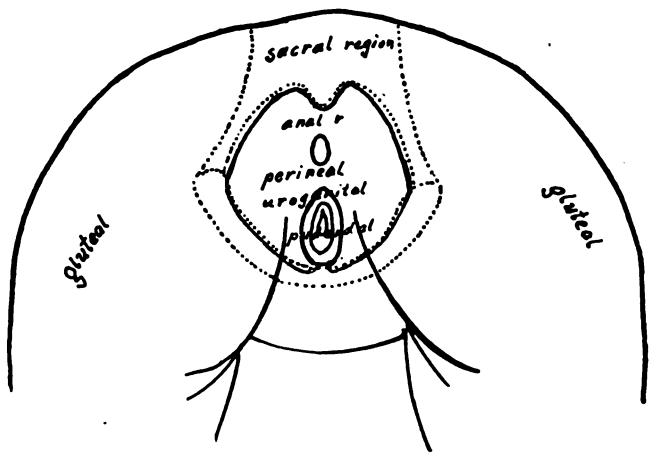


FIG. 206.—Regions of Female Peroneum

Right iliac

A—Cecum
B—Right ureter
C—Right spermatic vessels
D—Small intestine

Left iliac

A—Sigmoid flexure of colon
B—Left ureter
C—Left spermatic vessels
D—Small intestine

Epigastric
- A—Stomach
- B—Left lobe of liver
- C—Aorta
- D—Inferior vena cava
- E—Azygos (vena azygos major)
- F—Thoracic duct
- G—Semilunar ganglia
- H—Celiac axis

Umbilical
- A—Transverse colon
- B—Body of pancreas
- C—Transverse part of duodenum
- D—Aorta

Hypogastric
- Convolutions of small intestine
- The uterus (in pregnancy)
- The normal bladder in children
- The distended bladder in adults

G—LIVER

Definition
- Largest gland in the body, situated in the right hypochondriac, epigastric and left hypochondriac regions

Dimension
- Weight 50 ounces
- Length 10–12 inches
- Thickness 6–8 inches
- Width 3 inches

Surfaces
- 1—Upper, in relation with the diaphragm
- 2—Under surface, in relation with the abdominal viscera
- 3—Right extremity in relation with the diaphragm
- 4—Anterior in relation with the abdomen
- 5—Posterior in relation with the posterior abdominal wall

Ligaments
- 1—Broad, falciform or suspensory from the anterior surface of the diaphragm to the liver
- 2—Ligamentum triangular dextra and senestra (lateral right and left) lateral border of liver to diaphragm
- 3—Coronary from posterior aspect of the diaphragm to the liver
- 4—Round ligament (Teres) obliterated umbilical vein of fetus, from the region of the umbilicus to the liver

Fissures (arranged in figure H)

1—Fossa ductus venosus (fissure of ductus venosus) posterior ½ of longitudinal fissure
2—Fossa of umbilical vein (umbilical fissure) anterior ½ of longitudinal fissure
3—Transverse fissure, 2 inches in length
4—Fossa vesica fellae (gall bladder fissure), right anterior one-half of right longitudinal fissure
5—Fossa for vena cava (fissure from vena cava), posterior ½ of right longitudinal limb

Lobes

1—Lobus dextra (right lobe)
2—Lobus senestra (left lobe)
3—Lobus quadratus (quadrate)
4—Process caudatus (caudate)
5—Lobus caudatus (spigelian)

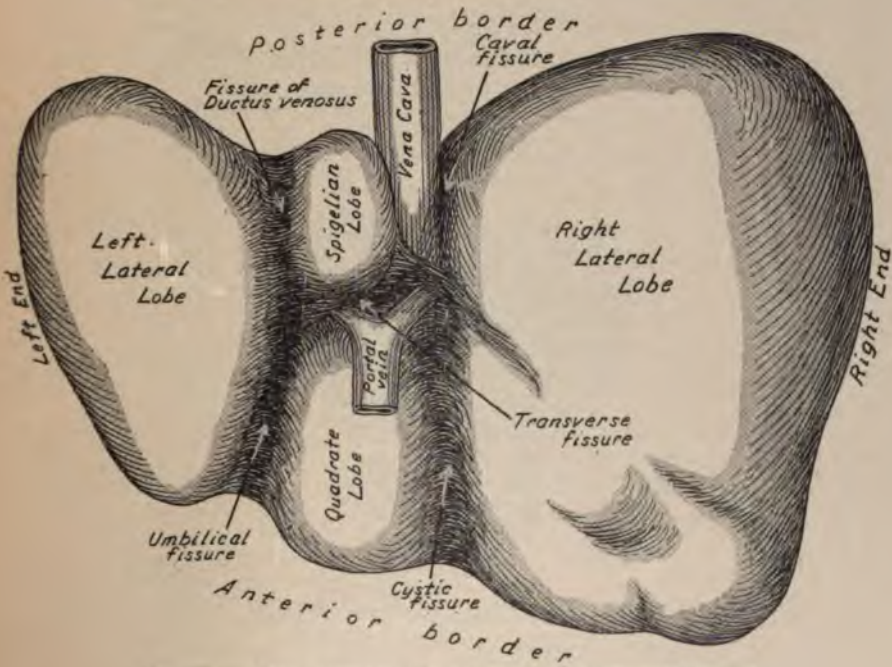


FIG. 207.—Under Surface Liver Showing Lobes and Fissures

Vessels

1—Hepatic artery
2—Portal vein
3—Hepatic vein
4—Lymphatics

5—Biliary duct

Topography of the liver

The upper border of hepatic dullness is found in the mamillary line at the level of the sixth rib, in the midaxillary line at the eighth rib, and in the scapular line at the tenth rib. The lower margin of dullness is situated in the middle line in front, about a hand's breadth below the junction of the gladiolus and ensiform; in the right mamillary line it reaches the costal margin; in the midaxillary it is in the tenth intercostal space and behind, in the scapular line it blends with the dullness over the right kidney

Histology

1—Liver surrounded by a capsule called Glisson's capsule

2—Liver substance consists of lobules about the size of a millet seed

3—Each lobule consists of

A—Liver cells

B—A plexus of lobular veins

C—The central or intra-lobular vein

D—A plexus of lymphatic vessels

E—A plexus of nerves

F—A plexus of bile ducts

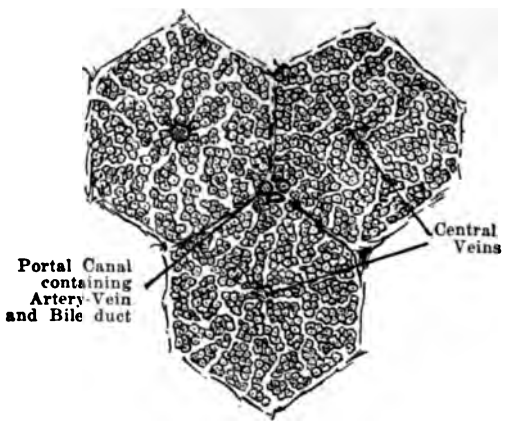


FIG. 208.—Three Lobules of Liver

II—*VESICA FELLEA (GALL BLADDER)*

Definition

A pear-shaped bag, placed on the under surface of liver

Dimensions

Length, four inches

Width, one inch

Capacity, eight to ten drams

Examination
Shows
Fundus
In relation with the parietes opposite the tenth costal cartilage
Body
In relation with the liver, 1st part of duodenum, pylorus, hepatic flexure of colon
Neck
Connects the fundus with the body
Biliary ducts
a—Hepatic ducts, issue from transverse fissure formed by the union of right and left hepatic ducts in two layers of omentum minus (lesser omentum)
b—Cystic duct, duct of gall bladder, one inch in length
c—Ductus Communis Choledochus. Formed by the union of the hepatic and cystic ducts. It is about

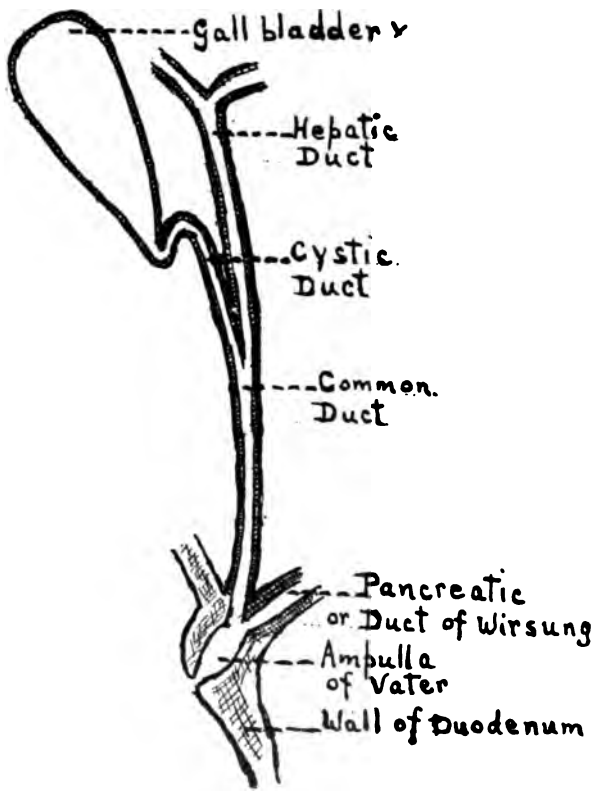


Fig. 209.—Diagram of Biliary Ducts

three inches long and the size of a goose quill; it descends behind the first part of the duodenum in front of the portal vein and enters the small intestine obliquely with the pancreatic duct

Structures

Two coats to the gall bladder and ducts

A—Mucous internal coat, composed of columnar epithelium and mucous glands

B—Fibrous or external coat is of strong areolar tissue

Artery

Cystic artery, branch of hepatic

I—PANCREAS

Definition

A compound racemose gland, placed in the epigastric and both hypochondriac regions directed transversely across the posterior wall of the abdomen

Length

Six to eight inches

Consists

Of a body, enlarged to the right at its head with which the body is connected by a narrow part or neck and narrowed to the left, where it ends as the tail

Relations of the body

Front

Stomach and small omentum

Behind

Aorta, crura of diaphragm, splenic vein, left kidney, left suprarenal body and left renal vessels

Upper border

From right to left

Celiac axis, splenic artery

Lower surface

From right to left

Superior mesenteric vessels, inferior mesenteric vein, transverse colon

Left end or tail

Touches lower part of the anterior surface of the spleen

Right end or head

Embraced by three parts of duodenum from which it is partly separated, behind by bile duct and in front by the lesser sac of the peritoneum. Behind it lies on the 1st and 2nd lumbar vertebrae from which it is separated by the crura of the diaphragm inferior vena cava, superior

mesenteric vessels and portal vein. The superior mesenteric vessels overlap the left end of the head; lying in a groove on this surface is the pancreatic duct (canal of Wirsung), which extends transversely from left to right and opens into 2nd part of the duodenum in common with the ductus communis choledochus

Arteries

Pancreatic of splenic, superior pancreatico-duodenal of hepatic, and inferior pancreatico-duodenal of superior mesenteric

Veins

Open into splenic and superior mesenteric

Nerves

From the solar plexus (sympathetic)

Histology

The pancreas consists of long tubular acini of columnar or polygonal epithelial cells, supported by very loose fibrous tissue. The cells are of the serum secreting type. Their inner portion shows granules, the outer part is clearer and sometimes striped. The pancreas has therefore a general resemblance to the parotid gland but differs from it in two respects

A—The intralobular ducts are lined by flat epithelium and are inconspicuous

B—Between the acini here and there are islands of epithelial cells without any glandular arrangement. These are the islands of Langerhans. In some of the acini close to the lumen, stellate cells can be seen. These are the centroacinar cells of Langerhans and are probably continued into the acini from the small ducts. There are spaces between the cells continuous with the lumen of the acini. The larger ducts are lined with columnar epithelium, with a few goblet cells here and there, and the largest ducts have a ring of non-striped muscle in the fibrous wall. Numerous nerve fibers with nerve cells in their course run through the pancreas and end among the cells; some of the nerve processes may terminate in Pacinian corpuscles

DUCTLESS GLANDS

SPLEEN

Definition

Glandular organ in the left hypochondriac region which embraces the left extremity of the stomach

Anatomy

Outer surface

Convex in relation to the diaphragm; corresponds to 9th, 10th, 11th ribs

Inner surface

Concave, presents a fissure called hilum in relation to the stomach, tail of the pancreas and the diaphragm

Upper extremity

Attached to the diaphragm by a suspensory ligament

Lower extremity

In relation to the splenic flexure of the colon

Anterior border

Thin and presents a notch

Posterior border, thick in relation to the left kidney

Histology

Surrounded by a fibrous capsule, which encloses splenic pulp which shows

A—Lymphatic nodules of the spleen (malpighian corpuscles), whitish bodies 1/25–1/60 inch, situated about the blood vessels

B—Colored elements, free blood cells, and crystalline bodies

C—Colorless elements, cells with or without nuclei

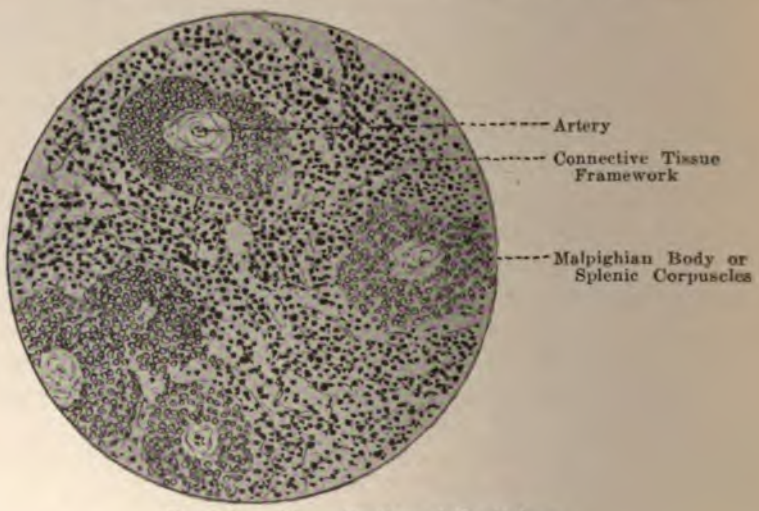


FIG. 210.—Cross Section of the Spleen

Dimensions

Length, 5 inches

Thickness, 1½ inches

Width, 3–4 inches

Weight, 7 ounces

Arteries

Splenic artery

Empties into spaces or directly into veins

Lymphatics

Empty into thoracic duct

Nerves

Solar plexus, semilunar ganglion, right vagus

THYROID GLAND

Definition

Gland situated in front and upper part of the trachea at the sides of the esophagus and lower portion of the pharynx and larynx. Weight 1½ ounces: laterally covered by

A—Common carotid arteries

B—Inferior thyroid arteries

C—Internal jugular veins

D—Vagus (pneumogastric) nerves

E—Recurrent laryngeal nerves

F—Filaments of the sympathetics

Anatomy

Lateral lobes, 2 inches long, ¾ inch thick. Extend from the inferior cornua of the thyroid cartilage to the 5th cartilage of the trachea

Isthmus

Connects 2 lateral lobes and lies across the trachea at level of 3d to 4th ring

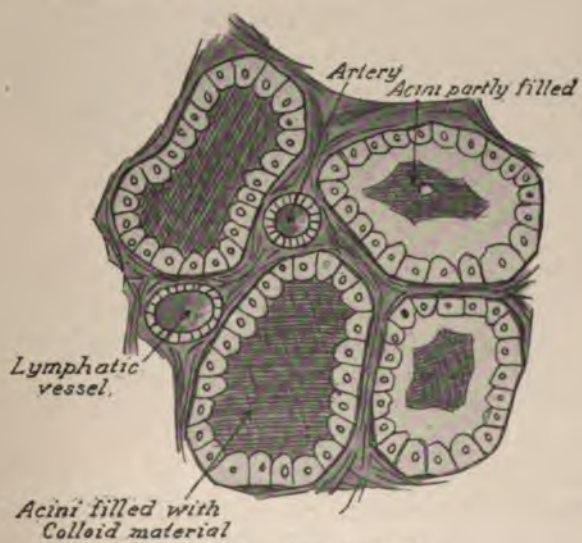


FIG. 211.—Thyroid Gland

Pyramid or (3rd lobe)

Situated between the hyoid bone and the isthmus. Often absent

Histology

Surrounded by capsule and composed of small vesicles held together by connective tissue

Arteries

Thyroid

Veins

Thyroid

Nerves

Middle and inferior cervical ganglion of sympathetic

SUPRARENAL CAPSULES

Definition

Two triangular flattened organs covered with fat that lie on either side of the spine, in close proximity to the upper kidney border

Histology

Each suprarenal is invested in a fibrous capsule and a liberal supply of fat. The capsule contains many elastic fibers and some smooth muscle cells. The cortex shows a radial structure and is divided into three zones

a—The zona glomerulosa, next to the capsule, consists of a row of columnar epithelial cells folded in such a way as to form oval bodies or elongated heads separated by strands of connective tissue from the capsule

b—The zona fasciculata makes up the larger portion of the cortex and consists of anastomosing columns of epithelial cells, a continuation of the zona glomerulosa. Each column has two rows of polygonal cells that are smaller than those of the glomeruli

c—The zona reticularis borders on the medulla and is coarsely vascular. The cells are smaller than those of the cortex and are grouped in round or oval masses

THYMUS

Definition

Soft, lobulated, pinkish mass situated at the upper part of the anterior mediastinum and lower part of the neck; most extensive

development at second year. Weight about one-half ounce, length two inches, disappears at puberty

Anatomy

Base

At upper portion of the pericardial sac

Apex

Lower border of the thyroid cartilage

Anterior surface

Convex in relation to the sternum

Posterior surface

Concave in relation to the pericardium and arch of the aorta

Histology

1—Capsule sends in trabeculae which divide it into compartments

2—Lobule, size from pin head to pea

3—Remains of epithelial structure called Hassall's corpuscles

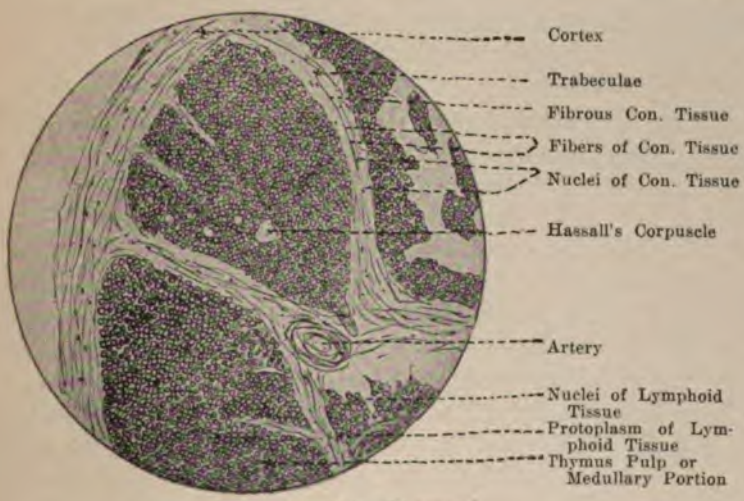


FIG. 212.—Thymus

Arteries

1—Internal mammary artery

2—Inferior thyroid artery

3—Superior thyroid arteries

Veins

Open into left innominate and thyroid veins

Nerves

Tenth cranial and sympathetic

RESPIRATORY APPARATUS

LARYNX

Definition

Organ of voice, situated at the upper part of the air passages, between the trachea and the base of the tongue in the upper and fore part of the neck, where it forms a considerable projection in the middle line

Relation

Behind

Forms part of the anterior boundary of the pharynx and is covered by the mucous membrane lining that cavity

Above

It is broad, where it presents the form of a triangular box flattened behind and at the sides

Below—it is narrow and cylindrical

It is composed of the following cartilages

A—Thyroid
B—Cricoid
C—Epiglottis
D—Two arytenoid
E—Two cornicula
F—Two cuneiform

The cartilages are connected together by ligaments and moved by numerous muscles. The interior is lined by mucous membrane. The superior aperture is wide in front, narrow behind and is bounded above by the epiglottis. The cavity of the larynx extends from the superior aperture to the lower border of the cricoid cartilage and is divided into two parts by the true vocal cords. The space between the true cords is called the glottis, the boundary of which is called the rima glottidis. The true cords extend from the angles of the arytenoid cartilages to the receding angle of the thyroid; above the true cords, are the false cords, between them is a cavity called the ventricle of the larynx. The blood supply is derived from the superior and inferior thyroid. The superior laryngeal nerve pierces the thyrohyoid membrane and supplies sensation to the interior of the organ. The recurrent laryngeal is the motor nerve to all the muscles excepting the cricothyroid, which is supplied by the superior laryngeal

Cartilages

1—Thyroid

Resembles a shield, composed of two quadrilateral plates or

alae joined to form an acute angle. The highest point is called "pomum adami," the upper border is attached to thyro-hyoid membrane, the lower border is attached to the crico-thyroid membrane. Posterior border shows superior and inferior cornua

2—Cricoid

Shaped like a ring, broad behind and narrow in front; articulates with the inferior cornua of the thyroid cartilage. It corresponds to the lower fifth cervical vertebra

3—Arytenoid

Two small nodules of yellow elastic cartilage; articulate with the cricoid cartilage; apex articulates with the cartilages of Santorini

4—Cornicula Larynges Santorini

Two small nodules of yellow elastic cartilage; articulate with arytenoid cartilages

5—Cuneiform (Wrisberg)

Two rods of yellow elastic cartilage contained in the free border of aryteno-epiglottidean fold

6—Epiglottis

Flat lamella of yellow elastic cartilage, resembles a leaf, connected to the angle of the thyroid cartilage, hyoid bone and base of tongue; base unattached, broad and rounded

7—Muscles

Divided into two sets

- Glottis
  - Crico-thyroid
  - Thyro-arytenoid
  - Crico-arytenoid lateralis
  - Crico-arytenoideus posticus
  - Arytenoideus
- Epiglottis
  - Thyro-epiglottideus
  - Aryteno-epiglottideus inferior
  - Aryteno-epiglottideus superior

8—Ligaments

Extrinsic ligaments

- Thyro-hyoid membrane
- Lateral thyro-hyoid ligaments

Intrinsic ligaments

- Crico-thyroid membrane
- Hyo-epiglottic ligament
- Crico-thyroid, capsular ligament
- Posterior crico-arytenoid ligaments

Thyro-epiglottic ligament
Crico-arytenoid, capsular ligament

Cavity of Larynx

Divided into two portions by the true vocal cords; its opening is called rima glottidis; it is 1 inch in length. In tranquil breathing it is triangular, base directed backward. In violent respiration it is lozenge shaped. When sound is produced it is a narrow slit

True vocal cords

Below false vocal cords, strong bands of yellow elastic tissue continuous with the crico-thyroid membrane, inserted into the anterior angle of the arytenoid and the receding angle of the thyroid cartilage

Superior Aperture

Triangular in form bounded in front, by the epiglottis on either side by the aryteno-epiglottidian fold

False Vocal cords

Higher in larynx, extend from the receding angle of the thyroid cartilage to the anterior surface of the arytenoid cartilage

Ventricle of larynx

The space between, true and false vocal cords

Sacculus laryngis

The space between thyroid cartilage and superior vocal cords

Mucous membrane

Ciliated columnar epithelium below superior vocal cords. Remainder of larynx is covered with squamous epithelium. glands are simple tubular

Vessels

Superior and inferior thyroid arteries

Nerves

Superior laryngeal
Inferior or recurrent laryngeal

TRACHEA

Definition

Cartilaginous membranous tube from the cricoid cartilage of the larynx at the level of the 5th cervical and extends to 3rd dorsal vertebra where it bifurcates into right and left bronchus composed of cartilaginous rings connected by fibrous membrane, lined by mucous membrane. Cartilages 20 in number. Each cartilage forms 2/3 of a ring, covered at their incomplete portion posteriorly by the trachealis muscle. The first cartilages

broader and thicker and the last cartilage shows openings of two incomplete rings. Length 4½ inches

Histology

1—Mucous membrane, columnar ciliated epithelium

2—Muscular, longitudinal and transverse

3—Fibrous membrane, outer coat

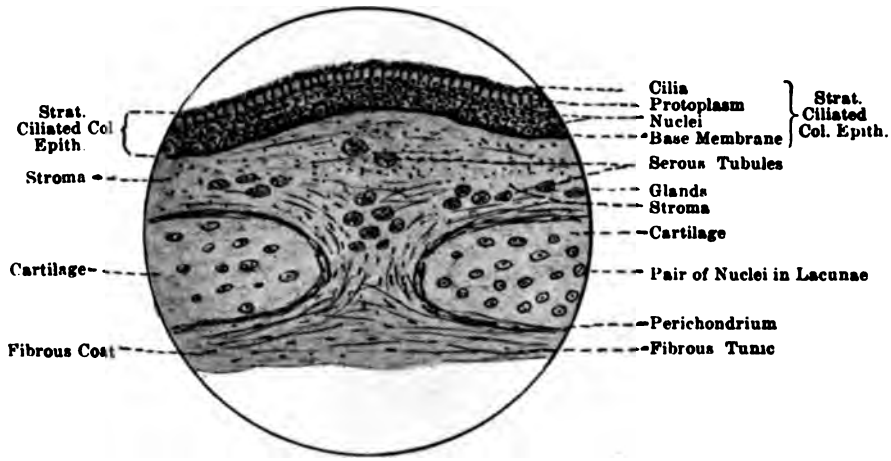


FIG. 213.—Trachea

Nerve supply

The recurrent laryngeal and sympathetic

Arteries

Inferior thyroid and bronchial

Relation

In front

A—Isthmus of the thyroid gland

B—Inferior thyroid vein

C—Remains of thymus gland

D—Left vena innominata

E—Arch of the aorta

F—Arteria innominata and the left common carotid artery

G—Cardiac plexus

H—Bifurcation of the pulmonary artery

I—Sternum, sternal muscles, fascia and integument

Behind

Esophagus

Right recurrent laryngeal nerve

Laterally

Lateral lobes of the thyroid gland

Common carotid arteries
Internal jugular veins
Pneumogastric and sympathetic nerves
Inferior thyroid arteries
Left recurrent laryngeal nerve
On the right side
Right vena innominata
Right phrenic nerve
On the left side
Left subclavian artery
Left phrenic nerve

BRONCHI

Definition

Right and left commence at bifurcation of the trachea at the 3rd dorsal

Right

Wider than the left, lies more horizontally; one inch in length; enters right lung on level with 4th thoracic vertebra

Left

Smaller, more oblique; 2 inches long; enters root of the left lung at 5th thoracic vertebra

On entering lung the bronchi divide the right into two, the left into three divisions

Cartilaginous rings extend to 2nd or 3rd divisions

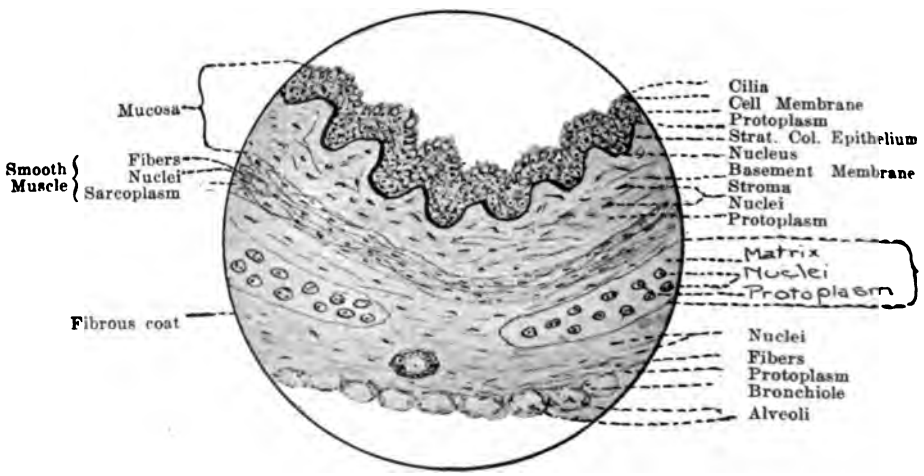


FIG. 214.—Bronchus

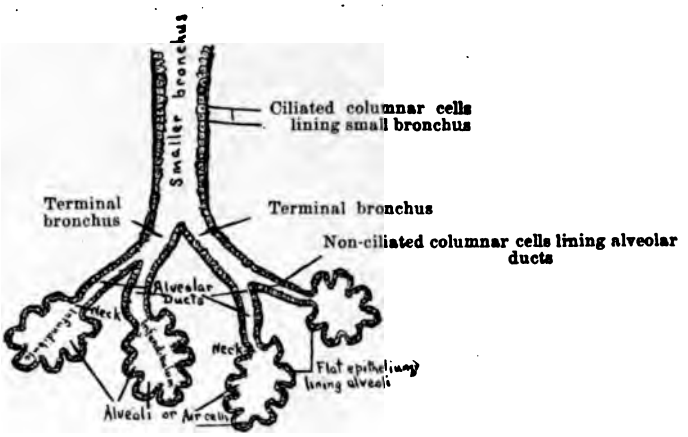


FIG. 215.—Diagram of Bronchial Terminations

IGS

Definition

Essential organ of respiration, characterized by light density, porous structure, crepitation on pressure and elasticity

Anatomy

1—Color pink at birth and gray in adult

2—Outer surface

Convex on either side a deep fissure, extends to the base; on the right lobe an additional fissure divides the lung into three lobes

3—Inner surface

Concave on the left side, excavated for heart

4—Anterior border

Shorter, coming in contact with other border of the lung in middle of sternum

5—Posterior border

More vertical, longer, thicker and rounder

6—Base

Broad and concave in relation with diaphragm, base of left lung lower on account of liver on the right

7—Apex

Passes into root of neck for about 1 inch above first rib

8—Root or Hilum

That portion of lung where the vessels enter

9—Relations

From before backwards

a—The pulmonary veins and the anterior pulmonary plexus

b—Pulmonary artery

c—The bronchus with its vessels, lymphatics and the posterior pulmonary plexus

These relations are the same upon each side of the body and may be easily remembered by the initial letters of the more important structures, viz., V. A. B.

From above downwards

On right side of body

1—Bronchus

2—Pulmonary artery

3—Pulmonary veins

On left side of body

1—Pulmonary artery

2—Bronchus

3—Pulmonary veins

The root of the right lung lies posteriorly to the superior vena cava and the right auricle of the heart, and the azygos artery arches over it from behind forwards

The root of the left lung passes beneath the arch of the aorta and in front of the descending portion of the arch the esophagus and the thoracic duct

The root of each lung has also in front of it the phrenic nerve and behind it the vagus nerve

Histology

Parenchyma

A—Bronchial tube

B—Lobule

Arranged about the bronchioles, like leaves upon a twig; average size one-twelfth inch in diameter, contains an air compartment—diameter one twenty-second to 1/200 of an inch. Interior of each lobule shows air cells lined by ciliated epithelium, each air sac from within out shows

1—Pavement epithelium

2—A basement membrane

3—Six plexuses

Pulmonary arteries

Pulmonary veins

Bronchial arteries

Bronchial veins

Nervous plexus

Lymphatic vessels

4—Elastic tissue of the lungs

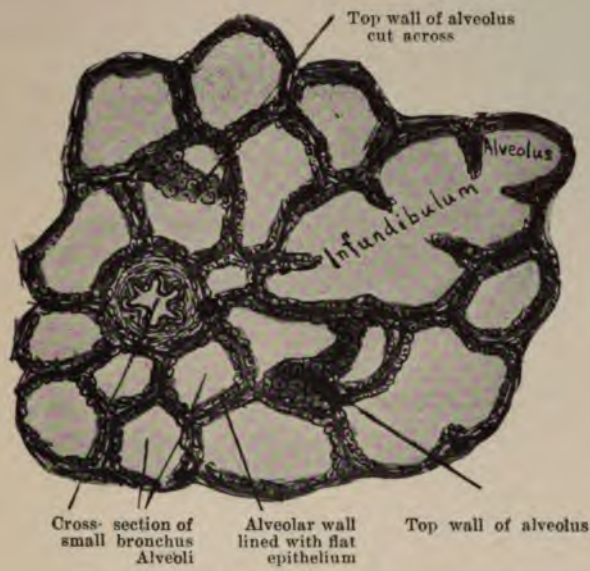


FIG. 216.—Section of Lung

c—The lungs receive blood through the bronchial arteries for their own nutrition, and venous blood through the pulmonary artery for aëration. The bronchial veins empty on the right side into the azygos and on the left into the superior intercostal.

The nerve supply is derived from the anterior and posterior pulmonary plexuses

PLEURAE

Description

Are two serous sacs enclosing and investing the lungs. Each pleura consists of

A—Visceral layer

Covers the lung

B—Parietal layer

Lines the inner surface of the chest walls, the upper surface of the diaphragm and the sides of the pericardium

The visceral and parietal layers of the corresponding pleura become continuous in front and behind the root of the lung and below the root a fold, the ligamentum latum pulmonis, extends downwards along the inner surface of the lung to the diaphragm. The mediastina are formed by the visceral layers of each side approaching one another towards the median line

Topography

The limits of the parietal pleurae are as follows

Each extends upward into the neck, forming a dome-like process over the apex of the lung about two inches above the first costal arch; from this the pleura passes downwards and forwards to the posterior aspect of the sterno-clavicular joint of each side and meets its fellow in the mid-line at the manubrio (corpussterni) gladiolar articulation; they pass down together to level of fourth costal cartilages, where the right pleura passes vertically to level of seventh right costal cartilage in mid-line; then downwards and backwards along eleventh rib to reach spine at neck of twelfth rib. Behind it passes upwards on right side of the bodies of the vertebrae to the apex. At the level of the fourth costal cartilage the left pleura arches outwards, leaving uncovered part of the anterior surface of the pericardium and lying about three-quarters of an inch from the margin of sternum, to reach seventh costal cartilage, where it follows same line as on right, but is placed at a slightly lower level

GENITO URINARY APPARATUS

KIDNEY

Definition

Two glandular organs on either side of the body in the back part of the abdominal cavity, extend from the eleventh rib to the crest of the ilium and are four inches long, two inches broad and one inch thick

Anatomy

Anterior surface

On right side in relation with the liver, descending duodenum and ascending colon. On the left side, in relation with the tail of pancreas, descending colon and lower portion of spleen

Posterior surface

Flat and in relation with the crus of the diaphragm, eleventh and twelfth ribs and psoas major muscle

Superior extremity

Largest and thickest and capped by supra renal capsules

Inferior extremity

Corresponds to the crest of the ileum

Outer border convex

Inner border concave

Marked by a depression called the hilum of the kidney

Section

A—Inner portion called "medullary portion," formed by pyramidal shaped structures, eight to eighteen in number; bases directed to the surface of the organ; apices point inwards and terminate in projections called papillae formed by collecting tubes and tubes of Henle

B—Outer portion called cortex, three-fourths of the thickness of the entire organ

Consists of

a—Uriniferous tubes of various forms

b—Malpighian bodies or corpuscles

c—Blood vessels

d—Nerves

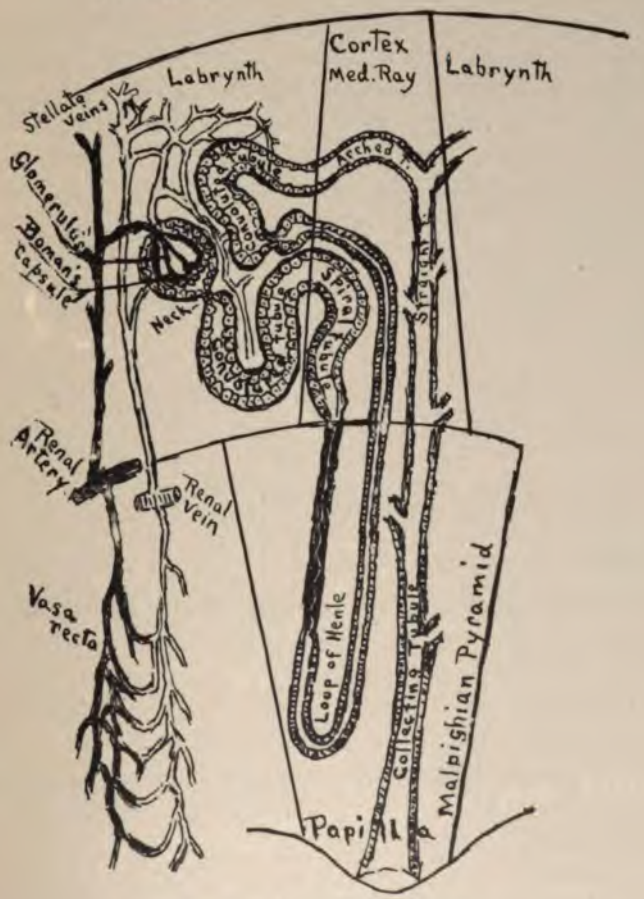


FIG. 217.—Diagram of Kidney

e—Lymphatics
f—Connective tissue (inter-tubular stroma)
g—Granular matrix

Histology
Uriniferous tubule

Blood vessels of kidney
The renal artery enters the kidney at the hilus, and divides into branches that pass toward the cortex, then turn over and form arches in the region between cortex and medulla.
From these arches vessels pass to the surface which are called the interlobular arteries; they give off vessels at right angles which are the afferent vessels of the glomerulus, break up into capillaries which ramify between the convoluted tubules. These unite to form veins (interlobular veins) which accompany the interlobular arteries.
They pass to venous arches, they unite to form the renal vein that leaves the hilus. These veins receive also others which have a stellate arrangement near the capsule (venae stellulae).
The medulla is supplied by the arteriae rectae. The veins (venae rectae) take a similar course and empty themselves into the venous arches. In the boundary zone groups of vasa recta alternate with groups of tubules, and give it a striated appearance

Nerves
Renal plexus

Lymphatics
Deep and superficial set open into lumbar glands

URETER

DEFINITION
Excretory duct of the kidney; the upper end is called the pelvis

PELVIS
Divided into
1—Infundibular
Two or three large prolongations into the main cavity of the pelvis
2—Calices
Smaller prolongations, seven to thirteen in number; embrace papills and empty into the infundibula

VATOMY

Sixteen to eighteen inches long, diameter of a goose quill

ISTOLOGY

Mucous coat

Spheroidal epithelium

Muscular

Fibrous

Relations of ureters in male and female

Pars abdominale (abdominal portion)

About five inches in length, lies upon the psoas muscle. The spermatic or ovarian vessels pass in front and the genito femoral (genito crural) nerve behind; on the right side the descending duodenum lies in front of the upper part and the line of attachment of the mesentery crosses it lower down.

On the left side the line of attachment of the mesentery of the pelvic colon crosses the ureter.

Pars Pelvica (Pelvic portion)

About four inches in length and passes on the lateral wall of the pelvis.

The ureter lies in front of the hypogastric (internal iliac) artery, about the level of the ischial spine; the ureter bends somewhat inward above the fascia of the pelvic floor to reach the bladder.

In this position it is crossed by the vas deferens in relationship with the upper end of the vesicula seminalis and passes in front of it to the bladder wall.

When the right and left ureters reach the bladder they are about two inches apart. They pierce the bladder wall very obliquely and are imbedded within its muscular tissue for nearly ¾ inch

They open into the bladder by two small slit-like apertures which are of a valvular nature and prevent a backward passage of fluid from the bladder.

In the female the ureter, near its termination, passes beneath the lower part of the broad ligament and lies to the outer side of the cervix uteri and upper part of the lateral wall of the vagina

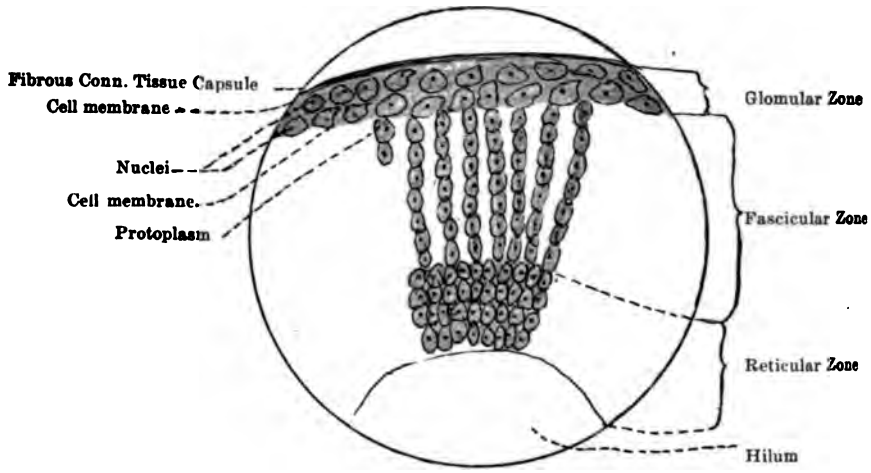


FIG. 218.—Supra Renal Gland (Adrenal)

BLADDER

IN INFANCY

It lies in the abdomen

IN ADULT

It lies in the pelvis behind the pubes, in the male in front of the rectum; in the female, it is placed in front of the uterus and vagina. The apex is connected to the umbilicus by the urachus and by the obliterated hypogastric arteries, the part posterior to the urachus being covered with peritoneum. The body is uncovered anteriorly by peritoneum and in front are the triangular ligament, the symphysis pubis, pubo-prostatic ligaments and the internal obturator muscles. Superiorly, it is covered by peritoneum in the upper part and is in relation with the rectum in the male and uterus in the female and with small intestines in both. Crossing obliquely on each side of the bladder is the umbilical (hypogastric) artery, which forms the lateral limit of the peritoneum. The vas deferens crosses obliquely the lower part of the lateral surface, along the inner side of the ureter and umbilical (hypogastric) artery. The base or fundus is directed backwards and downwards. The cervix or neck of the bladder is the part continuous with the urethra and is embraced in the male by the prostate. There are two sets of ligaments of the bladder, true and false. The true ligaments are two anterior and two posterior. These are formed of recto-vesical fascia. The urachus is usually described as the 5th or superior true ligament. The false

ligaments, five in number, are formed of peritoneum; there are two posterior, two lateral and an anterior, the latter covering the urachus

INTERIOR OF THE BLADDER

Upon the inner surface of the base of the bladder just behind the urethral orifice is a triangular smooth surface or trigone, with the apex looking forwards. It is bounded laterally by two ridges passing to the openings of the ureters, the posterior angle being formed by those openings, placed 1½ inches apart; at its apex there is an elevation, formed by the prostate, called the uvula vesica, which is 1½ inches from the ureters. The mucous membrane over the trigone is smooth but everywhere else elevated upon the irregular muscular wall and rugae

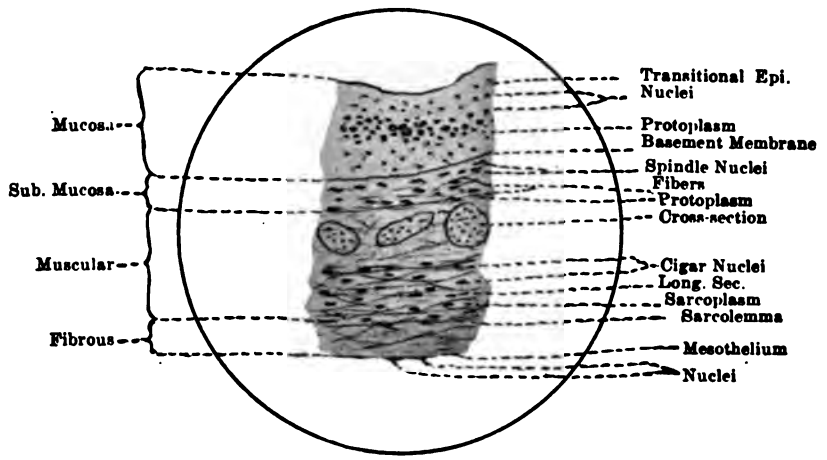


FIG. 219.—Bladder

PENIS

DEFINITION

A mass of erectile tissue enclosed in three compartments

DESCRIPTION

I—Corpora cavernosa, two masses of erectile tissue on either side of the penis, attached posteriorly by crura to tuberosities of the ischium; shows for examination

1—Bulb of the corpus spongiosum, a slight enlargement of each crus

2—Suspensory ligament which connects the root of the organ to the symphysis pubis

II—Corpus spongiosum
An erectile tube on the inferior surface between the corpora cavernosa, having within it the urethra; it is expanded at the end to form the glans penis; at the base it shows the corona glandis, behind which is the cervix
III—Preputial glands (Glands of Tyson) which secrete smegma on the corona and cervix
IV—Meatus urinaris, external orifice of the urethra
V—Prepuce
Prolongation of the integument over the penis

BLOOD SUPPLY
Internal pudic

NERVE SUPPLY
Internal pudic

URETHRAL CANAL

DESCRIPTION
Eight and one-half inches long, divided into three portions
1—Prostatic portion
That portion that pierces the prostate gland; one and one-half inches long; this is the widest portion of the urethral canal
On the floor
a—Verumontanum
It consists of a longitudinal ridge, three-quarters of an inch in length, and is by some supposed to be the chief seat of sensation during sexual intercourse
b—The prostatic sinuses are situated upon either side of the verumontanum and into them open the ducts of the prostate gland
c—The sinus pocularis is a small cul-de-sac which extends into the middle lobe of the prostate and resembles in its shape the female organ of conception
d—The seminal ducts open into the anterior part of the prostatic portion of the urethra
B—Membranous portion
Between two layers of triangular ligament, very thin

and destitute of erectile tissue, shows ducts of (Cowper's glands) bulbo-urethral glands on the sides of the urethra

C—Spongy portion

Six inches long

1—Bulb the upper end of which contains openings of bulbo-urethral glands (Cowper's glands)

2—Fossa navicularis, lower dilatation of urethra which shows Lacuna urethralis (glands of Littre)

3—Meatus urinarus, external orifice

TESTICLE

DEFINITION

The organ that secretes seminal fluid. It is oval and is suspended by the spermatic cord

Covered by

A—Integument of the scrotum

B—Dartos of the scrotum

C—Intercolumnar or external spermatic fascia

D—Cremasteric layer

E—Fascia propria or infundibuliform process

F—Tunica vaginalis (two layers)

1—The epididymis is an appendix to the testicle. It lies on the posterior border; the upper extremity or head is attached to the testicle and gives passage to the efferent duct

2—Central portion or body is attached to the posterior border of the testicle by the tunica vaginalis

3—Lower extremity is pointed and attached to testicle

Cross section—fibrous layers of testicle called Tunica Albuginea sends in trabeculae which divide the organ into compartments. The vertical septum in the interior of the gland is called mediastinum testis. Gland is composed of seminiferous tubules which at the mediastinum form vasa recta, then form rete testis, then escape as vasa efferentia into the epididymis

Vas Deferens, conveys secretions from the epididymis to the ejaculatory duct

Course

A—Along the inner side of the epididymis and the testicle

B—Along the back part of the spermatic cord to the abdominal inguinal ring (external abdominal ring)

C—Through the two rings of the abdomen and the inguinal canal

D—Between the bladder and the rectum to the inner side of the vesicula seminalis

E—Joins at the base of prostate with the duct of the vesicula seminalis to form the ejaculatory duct

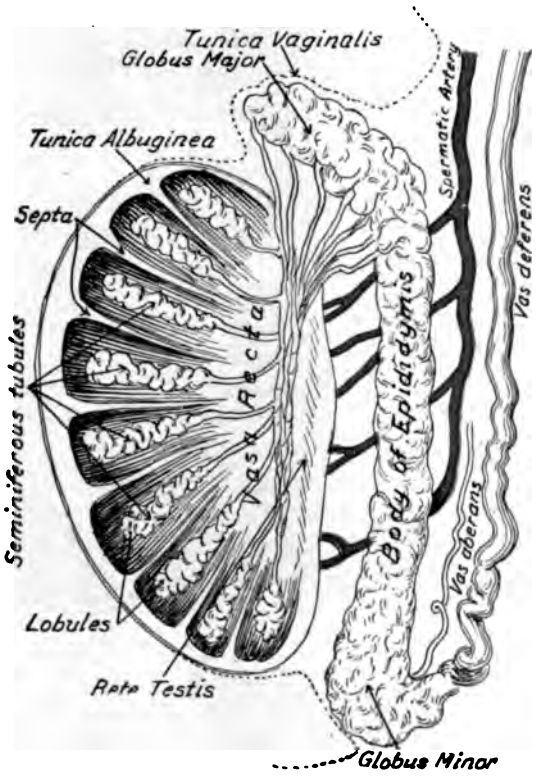


FIG. 220.—Tunica Vaginalis (Globus Major)

Vesiculae Seminales

Two sacculated pouches that are reservoirs for semen, 2½ inches long, between the bladder and the 2nd part of the rectum. Each consists of a tube about six inches long, coiled on itself

The ejaculatory duct, is formed by the junction of ducts from the vesiculae seminales and the vasa deferentia, ¾ inch in length and terminating in the prostatic urethra on the side of the verumontanum

PROSTATE

DIMENSION

1½ x ¾ x ½ inches and weighs about three-quarters of an ounce

DESCRIPTION

It resembles a chestnut in size and form

SITUATION

It is situated at the neck of the bladder, and surrounds the first part of the urethra

COMPOSITION

It consists of fibromuscular (unstriated) tissue with imbedded follicular pouches, the whole enclosed in a firm fibrous capsule, continuous in front with the triangular ligament and behind with the posterior layer of the deep perineal fascia

ARTERIES

Are from the vesical, hemorrhoidal and internal pudic

NERVES

Are derived from the hypogastric plexus

SPERMATIC CORD

It extends from the globus minor of the epididymis to the subcutaneous inguinal ring (external abdominal ring) four inches long, composed of

1—Vas Deferens
2—Spermatic artery
3—Cremasteric artery
4—Artery of the vas deferens
5—Spermatic veins
6—Spermatic plexus of nerves
7—Branch of the ilio-inguinal nerve
8—Vas Aberrans of Haller
9—Coverings
10—Lymphatics

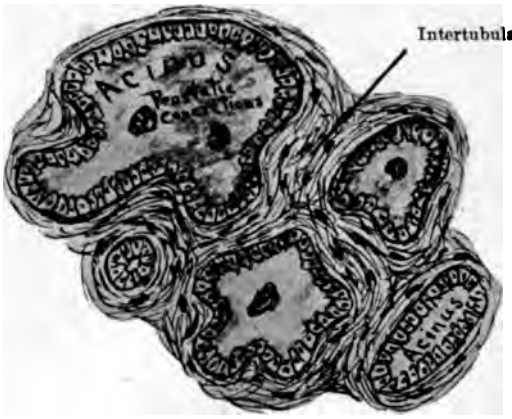


FIG. 221.—Prostate Gland

FEMALE ORGANS OF GENERATION

CLASSIFIED FOR DESCRIPTION

I—External organs called Pudenda or Vulva
- 1—Structures derived from the skin
  - Mons Veneris
  - Labia Majora
  - Labia Minora
- 2—Structures in the interlabial space
  - Vestibule
  - Meatus Urinarius
  - Introitus Vaginae
  - Hymen
- 3—Erectile structure
  - Clitorus
  - Bulbi vestibuli
- 4—Glands
  - Vulvo Vaginal (glands of Bartholin)
  - Periurethral glands

II—Internal organs
- 1—Vagina
- 2—Uterus
- 3—Tuba uterina (fallopian tubes)
- 4—Ovaries

DESCRIPTION

I—External reproductive organs

Mons Veneris

A collection of areolar and adipose tissue situated in front of the pubic symphysis covered by pigmented skin which at puberty becomes covered with hair

Labia Majora

Two longitudinal folds of modified skin extending from the Mons veneris to the perineum; their union in front is called the anterior commissure and their union behind is called the posterior commissure or fourchette; between the fourchette and the hymen is a depression called the fossa navicularis. The outer surface of the labia majora is pigmented and covered with hair

Labia Minora or Nymphae

Two smaller longitudinal folds within the labia majora surrounding clitorus above and forming its prepuce running downward for 1½ inches. They are composed of modified skin beneath which is a connective tissue rich in elastic and smooth muscular fibers

Vestibule

Triangular space bounded laterally by the nymphae and behind by the orifice of the vagina; the apex coincides with the clitorus

Meatus urinarius

The external opening of the urethra, situated an inch below the clitorus

Introitus vaginae

Inferior orifice of the vagina, surrounded by the sphincter vaginae and in the virgin covered by the hymen

Hymen

A double fold of mucous membrane covering the introitus vaginae; after rupture the remains are called the carunculae myrtiformes

Clitorus

About one inch in length, situated at the apex of the vestibule, homologous to the penis, but has no corpus spongiosum and no urethra. Composed of a glans, that portion beneath the anterior commissure, two corpora cavernosa, two crura, prepuce, suspensory ligament and muscle

Bulbi Vestibuli

Two masses of erectile tissue composed of a plexus of veins, situated on either side of the vestibule; the anterior extremity of each is continued forward by a narrower plexus called the pars intermedia, which communicates with its fellow beneath the clitorus

Vulvo vaginal glands

Two in number situated on either side of the vagina, about ½ inch long, their ducts open in a groove between the labia minora and the hymen; they are racemose glands and their secretion lubricates the vulva.

Urethral glands

From simple to racemose glands, situated beneath the mucous membrane of the urethra

Blood supply of the vulva

External and internal pubic arteries. Veins accompany the arteries

Lymphatics of the vulva

Empty into inguinal glands

Nerve supply

A—Pelvic and hypogastric plexus of the sympathetic

B—Genito-crural, inferior pudendal and internal pudic

II—Internal organs of reproduction

Vagina

Definition

Musculo, membranous canal, extending from the uterus to the vulva

Function

a—Organ of copulation

b—Affords passage of the menstrual flow and the fetus

Dimensions

2½ inches along anterior wall and 3½ inches along posterior wall; its walls are in contact and its upper end encloses the cervix uteri

Structure

a—Inner mucous lining covered with squamous epithelium, containing mucous crypts and follicles, two longitudinal raphés, called the columns of the vagina, and numerous transverse ridges called rugae

Blood supply

Internal pubic

Lymphatics

Terminate in the pelvic and inguinal glands

Nerves

Hypogastric plexus, 4th sacral and pudic

Uterus

Definition

A hollow, muscular organ situated in the pelvis behind the bladder and in front of the rectum

Function

Harbors and nourishes the impregnated ovum and expels the products of conception

Dimensions and shape

Length, 3 inches
Breadth, 2 inches
Thickness, 1 inch
Weight, 1 ounce
Shape, pear shape

Description

a—Fundus

Superior border of the uterus, is covered by peritoneum

b—Body, that portion between the fundus and the cervix, invested anteriorly and posterior surface covered with peritoneum; cavity of the uterus is triangular in shape, opens into cervix by the internal os

c—Cervix

That portion of the uterus between external and internal os; cavity is spindle shaped and shows transverse folds, proceeding from a longitudinal fold, called arbor vitae

Ligaments (8 in number)

a—Anterior ligament extends from the bladder to the uterus

b—Posterior ligament, extends from the rectum to the bladder

c—Broad ligaments, 2 in number from the sides of the uterus to the lateral walls of the pelvis. Contain within their folds the fallopian tubes, the round ligaments, the ovaries, parovaria, connective tissue, blood vessels and nerves

d—Round ligaments, 2 in number, from the lateral aspect of the uterus through the inguinal canal to the labia majora, each ligament is covered by a process of peritoneum which extends into the inguinal canal and is called the canal of Nuck

Histology

a—Mucous coat

Body

Smooth
Thin

Firmly adherent to the uterus
Has ciliated epithelium upon it
Has utricular follicles
Has a thin secretion

Cervix
Thrown into ruga
Thick
Loosely attached
Squamous epithelium
Glands of Nabothi
Thick viscid secretion

b—Muscular coat
Three layers longitudinal, circular and oblique

c—Serous
From the peritoneum for the upper two-thirds, lower one-half is connective tissue

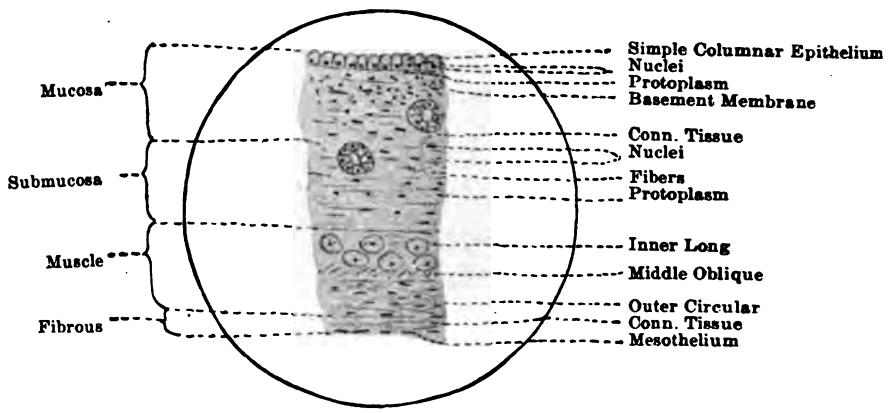


FIG. 222.—Uterus

Blood supply
Ovarian and uterine

Nerve supply
Hypogastric, ovarian plexus and from the third and fourth sacral

Tuba Uterina (Fallopian tubes)

Definition
Two tubes situated in the upper margin of the broad ligaments extending on either side of the uterus

Function
To convey the ovum to the uterus

Dimensions
Length, 4 inches

Width, 1/16 inch

Description

a—Interstitial portion, next to the uterus and is contained in the thickness of its walls, opens into the uterus by the ostium uterinum

b—Isthmus, constricted portion measures 1½ inches and is next to the interstitial portion

c—Ampulla, dilated portion, extends from the isthmus to the fimbriated extremity

d—Fimbriated extremity, movable part of the tube and receives the ova from the Graafian follicle; one of these fibria is attached to the ovary called fimbria ovarica

Histology

a—Mucous coat, ciliated, epithelium on a basement membrane

b—Muscular coat, inner circular, outer longitudinal

c—Serous or outer coat

Arteries

External tubular from the ovarian and the internal tubular from the uterine

Ovaries

Definition

Two almond shaped bodies on either side of the uterus below the uterine tubes and in the broad ligament

Dimensions

Length, one and one-half inches

Breadth, three-fourths inch

Thickness, one-half inch

Weight, one to two drams

Ligaments

a—Utero-ovarian

b—Tubo-ovarian

Histology

a—Surrounded by a fibrous tissue capsule, called the tunica albuginea, which is covered by a single layer of columnar epithelium, called the germinal epithelium; in this epithelium are large ovoid cells called the primordial ova

b—Beneath the tunica albuginea is a layer of spindle connective tissue cells called the ovarian stroma

c—Imbedded in the stroma lie the Graafian follicles which are surrounded by a condensation of the

stroma called theca folliculi. Inside the theca folliculi is a layer of granular cells called the stratum granulosum; at some points the cells of the stratum granulosum are heaped up, called cumulus oöphorus (discus proligerus) (cumulus ovigerus); upon this lies the ovum which in turn is surrounded by a layer of cells called the corona radiata. The cell wall of the ovum is called the zona pellucida, the protoplasm is called the vitellus, the nucleus is called the germinal vesicle and the nucleolus is called the germinal spot

d—The remains of the Graafian follicle after rupture are called the corpus luteum

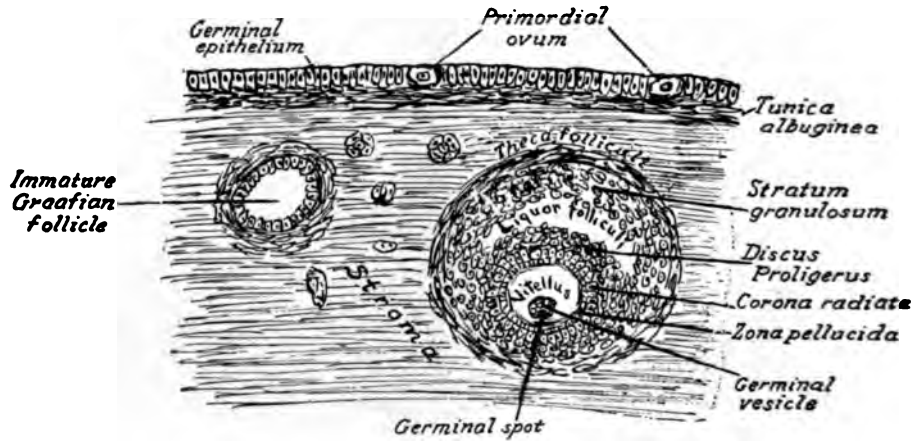


FIG. 223.—Ovaries

GLOSSARY

VISCERA

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
DIGESTIVE APPARATUS	
Arcus glosso-palatinus	Anterior pillar of fauces
Arcus pharyngo-palatinus	Posterior pillar of fauces
Gl. lingualis anterior	Gland of Nuhn
Ductus submaxillaris	Wharton's duct
Gl. parotis accessoria	Socia parotidis
Ductus parotideus	Stenson's duct
(Stenosis)	
Dentes praemolares	Bicuspid teeth
Dens serotinus	Wisdom tooth
Papillae vallatae	Circumvallate papillae

ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Recessus pharyngeus	Lateral recess of pharynx
Tela submucosa	Pharyngeal aponeurosis
Plicae circulares	Valvulae conniventes
Gl. intestinales	Crypts of Lieberkühn
Valvula coli	Ileo-caecal valve
Columnae rectales	Columns of Morgagni
Plicae transversales recti	Valves of Houston
Valvula spiralis	Valves of Heister
Noduli lymphatici aggregati (Pêyeri)	Peyer's patches
Intestinum jejunum	Jejunum
Intestinum ileum	Ileum
Noduli lymphatici lienales (Malpighii)	Malpighian corpuscles
RATORY APPARATUS	
ARYNX	
Prominentia laryngea	Adam's apple
Incisura thyreoidea superior	Superior thyroid notch
M. ary-epiglotticus	Aryteno-epiglottidean muscle
M. vocalis	Internal thyro-arytenoid muscle
M. thyreo-epiglotticus	Thyro-epiglottidean muscle
Appendix ventriculi laryngis	Laryngeal sac
Plica vocalis	True vocal cord
Plica ventricularis	False vocal cord
Ligamentum ventriculare	Superior thyro-arytenoid ligament
Ligamentum vocale	Inferior thyro-arytenoid ligament
Glottis	Glottis vera
Rima vestibuli	Glottis spuria
Cartilago thyreoidae	Thyroid cartilage
Membrana hyothyreoidea	Thyro-hyoid membrane
Cartilago corniculata (Santorini)	Cartilage of Santorini
Tuberculum epiglotticum	Cushion of epiglottis
Pars intermembranacea (rimae glottidis)	Glottis vocalis
Pars intercartilaginea (rimae glottidis)	Glottis respiratoria
Conuselasticus (membranae elasticae laryngis	Crico-thyroid membrane
Glandula thyreoidea	Thyroid gland

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Glomus caroticum	Intercarotid gland or body
NOSE	
Concha nasalis suprema (Santorini)	Highest turbinate bone
Concha nasalis superior	Superior turbinate bone
Concha nasalis media	Middle turbinate bone
Concha nasalis inferior	Inferior turbinate bone
UROGENITAL APPARATUS	
Corpuscula renis	Malpighian corpuscles
Paradidymis	Organ of Giralde's
Appendix testis	Hydatid of Morgagni (male)
Ductus deferens	Vas deferens
Gl. urethrales	Glands of Littré
Glandula bulbo-urethralis (Cowperi)	Cowper's gland
Folliculi oöphori vesiculosi	Graafian follicles
Cumulus oöphorus	Discus proligerus
Tuba uterina	Fallopian tube
Epoöphoron	Parovarium
Appendices vesiculosi	Hydatids of Morgagni (female)
Ductus epoöphori longitudinalis	Gartner's duct
Orificium internum uteri	Internal os (of uterus)
Orificium externum	External os
Processus vaginalis	Canal of Nuck
Glandula vestibularis major	Bartholin's gland
PERITONEUM	
Bursa omentalis	Lesser peritoneal sac
Foramen epiploicum	Foramen of Winslow
Lig. phrenico-colicum	Costo-colic ligament
Excavatio recto-uterina (cavum Douglasi)	Pouch of Douglas
Lig. gastro-lienale	Gastro-splenic omentum

THE EYE

DEFINITION

The organ of vision situated in the orbital cavity

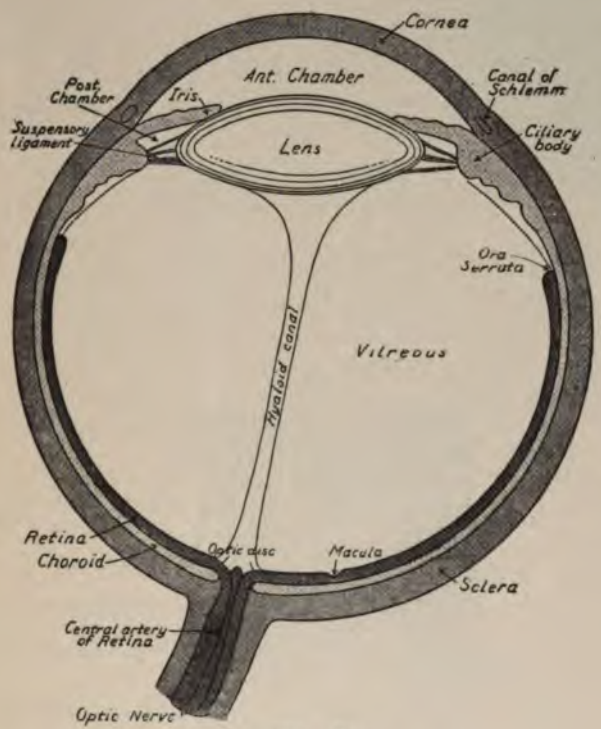


FIG. 224.—Eye

TS

I—Sclerotic

Covers the posterior five-sixths of the eyeball. Continuous in front with the cornea

Outer surface

White in color and affords attachment to the eye muscles

Inner surface

Brown and connected to choroid coat by lamina fusca. Grooved by ciliary vessels and nerves. A canal around the circumference of the iris is called the sinus venosis sclera (Canal of Schlemm). At the posterior portion, the sclerotic coat is pierced by the optic nerve. That portion of the sclera is called the lamina cribrosa sclera

Cornea

Covers anterior one-sixth of the eyeball. The circumference is nearly circular, more prominent than the rest of the eyeball. It is non-vascular and is supplied by corneal corpuscles

It consists of

1—Anterior epithelial coat (two or three layers)

2—Anterior elastic layer

3—Body of the cornea, fifty or sixty layers of cells (substantia propria)

4—Posterior elastic layer

5—Posterior endothelial coat (one layer)

II—Choroid

Vascular and pigmentary layer, continuous in front with the iris, ciliary processes and ciliary muscle and ligamentum pectinatum iridis consist of

A—External or venous layer

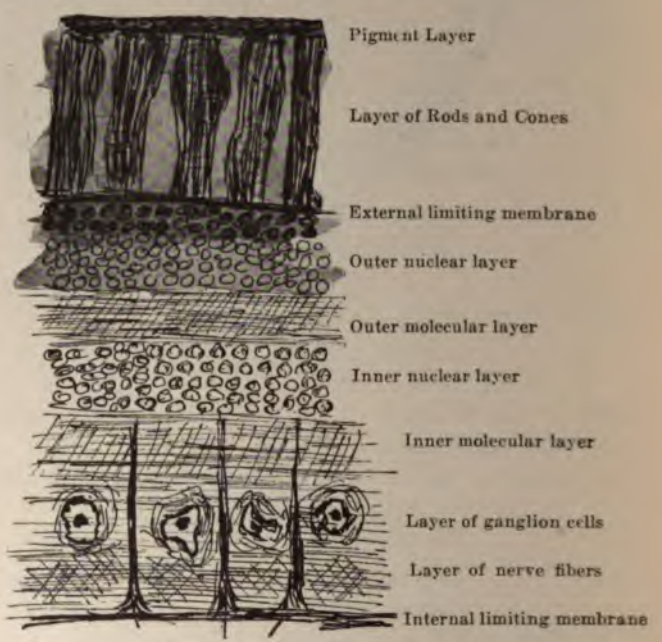


FIG. 225.—Retina

B—Middle or capillary layer

C—Internal or pigmentary layer

Anteriorly forms the ciliary processes. Numerous folds attached to the suspensory ligament

Iris

A perforated curtain; the opening called the pupil. The posterior surface of the iris is called the uvea. The anterior surface differs in various individuals, marked by wavy lines. The iris is composed of two sets of muscle fibers, circular and radiating

III—Retina

Nervous layer of the eye. The anterior margin is called the ora serrata. On the posterior portion can be seen

A—Optic disc (Colliculus), where the optic nerve enters

B—Macula lutea (yellow spot). Located on the temporal side of the optic disc

C—Fovea centralis in the center of the macula lutea, point of most acute vision

D—Orifice of escape of the arteria centralis retinae

Structure

Layers from within outward

a—Internal limiting membrane

b—Stratum opticum (layer of nerve fibers)

c—Ganglionic layer

d—Inner molecular layer

e—Inner nuclear layer

f—Outer molecular layer

g—Outer nuclear layer

h—External limiting membrane

i—Rods and cones

j—Stratum pigmenti

Refracting media

A—Aqueous humor

Contained in the space between the anterior surface of the lens and the posterior surface of the cornea. Divided by the lens into two chambers

B—Lens

A double convex, transparent body enclosed by a capsule and held in position by suspensory ligament surrounded by a canal called Spatia zonularia (Petit's canal)

Capsule of lens

Gives attachment to the suspensory ligament

C—Vitreous humor

Contained in the chamber between the posterior surface of the lens and retina. Enclosed in a capsule called hyaloid membrane

D—Ciliary muscle

A ring of involuntary muscle, serves to alter the shape of the lens for vision

APPENDAGES OF THE EYE

I—Eyebrows

A thick fold of skin covered with hair and corresponding to the upper margin of the orbital cavity

II—Eyelids

Two movable folds for the protection of the eye. United externally and internally in medial and lateral palpebral commissure (external and internal canthus)

The medial palpebral commissure (inner canthus) shows

Lacus lacrimalis, a triangular space in which is seen the caruncula lacrimalis and plica semilunaris

Composed of

A—Integument
B—Subcutaneous areolar tissue
C—Fibers of the orbicularis muscle
D—Tarsal cartilage
E—Medial and lateral palpebral raphe (tarsal ligaments)
F—Tendo oculi
G—Tensor tarsi muscle
H—Levator palpebral muscle (in upper lid)
I—Palpebral conjunctiva
J—Tarsal glands (Meibomian glands)
K—Eyelashes

III—Lacrimal apparatus

1—Lacrimal gland

Situated in a depression at the roof of the orbit the size of an almond and gives off six to eight ducts which open in the upper margin of the conjunctiva

2—Lacrimal canal

Begins in a small opening in the margin of the eyelids called puncta lacrimalis and empties in the lacrimal sac

3—Lacrimal sac

The upper and dilated portion of the naso-lacrimal duct

Naso-lacrimal duct

A membranous canal three-fourths of an inch in length which opens into the inferior meatus of the nose

THE EAR

EXTERNAL

I—Auricle (Pinna)

Composed of cartilage. It forms the projecting portion and assists in directing sound into the external acoustic meatus (external auditory canal)

A—Concha, central depression
B—Tragus, conical projection covered with hair

C—Antitragus, smaller eminence behind tragus
D—Helix, external curved margin of cartilage
E—Fossa of helix, groove beneath helix
F—Lobule, soft pendulous portion, which hangs from the lower cartilage of the ear

II—External acoustic meatus

That portion which extends from the concha to the membrane tympani. One and one-fourth inches in length

A—Cartilaginous portion one-half inch in length attached to the circumference of the external acoustic meatus
B—Osseous portion, three-fourths inch in length. Expanded into a rough margin for the attachment of the auricle

III—Tympanum cavum (middle ear)

Situated between the external acoustic meatus and the labyrinth of the ear

Membranous wall (outer)

Formed by membrane tympani and presents two openings

a—Iter chordae posterior
b—Iter chordae anterior
c—Petrotympanic fissure (Glaserian fissure)

Upper two openings for chorda tympani
Last opening for the long process of the malleus

Labyrinth wall (inner wall) shows

a—Promontory large eminence formed by the first turn of the cochlea
b—Fenestra Vestibulae (Ovale) opening into the vestibule closed by the stapes and annular ligament
c—Fenestra cochlea (Rotundum) opening into the scala tympani closed by the secondary tympanic membrane (internal membrane)
d—Pyramidal eminencia

Encloses cavity of stapedius muscle

e—Ridge of bone indicates the course of the facial canal (Aqueductus Fallopii)

Mastoid wall (posterior wall) shows

Presents opening of mastoid cells

Carotid wall (anterior wall) shows

a—Internal opening of the auditory tube
b—Opening for the tensor tympani muscle
c—Anterior pyramid
d—Processes cochlea forms a thin plate between the

auditory tube and the canal of the tensor tympani

Jugular wall (floor)

Corresponds to the jugular fossa of the petrous portion of the temporal bone

Tegmental wall (roof)

Separated from the cranial cavity by a thin plate of bone

Bones of tympanum

A—Malleus

Head articulates with the incus connected to the roof of the tympanum by the suspensory ligament. Neck for the laxator tympani muscle, manubrium or handle inserted into membrana tympani. Anterior process (Gracillis process) extends into the petro tympanic fissure (Glaserian)

Lateral process (Brevis). From the foot of the manubrium to the membrana tympani and gives attachment to tensor tympani

B—Incus

Body

Articulates with malleus

Long crus

Terminates in a nodule called lenticular process

Short crus

Attached to the posterior wall of the tympanum

C—Stapes

Articulates with the incus and is attached to the annular ligament around the fenestra vestibulae

Head

Articulates with the incus

Neck

Gives attachment to the stapedius muscle

Crura

Connects the neck of the bone with the base

Base

Broad and connected to the annular ligament

D—Muscles of the tympanum

Tensor tympani

Origin

From the under surface of the petrous portion of the temporal bone, and from the cartilaginous portion of the auditory tube

Insertion

Into the manubrium and the processus later-

alis of the malleus near to the root of that process

Laxator tympani

Origin

From the spine of the sphenoid bone and the auditory tube

Insertion

Into the anterior process of the malleus and occasionally into the neck of that bone

Stapedius

Origin

From the interior of the pyramid on the inner wall of the tympanum

Insertion

Into the back part of the neck of the stapes

E—Arteries of the tympanum

The tympanum receives its blood chiefly from the following

1—The tympanic branch of the internal maxillary which enters at the petro tympanic fissure

2—The tympanic branch of the internal carotid, which enters through a small foramen within the carotid canal

3—The stylo-mastoid artery (a branch of the posterior auricular) which enters the facial canal through the stylo-mastoid foramen

4—The vidian artery (a branch of the internal maxillary) which passes through the vidian canal and accompanies the large petrosal nerve through the hiatus Fallopii

5—The petrosal branch of the middle meningeal artery which enters at the hiatus facialis

6—Branches from the ascending pharyngeal artery which enters the tympanum along the auditory tube

F—Nerves

Branch of the otic ganglion

To tensor tympani

Tympanic of facial nerve

To stapedius and laxator tympani muscles

Tympanic or glosso-pharyngeal (Jacobson's nerve)

Chorda tympani, branch of facial nerve

To mucous membrane

G—Cavity lined with mucous membrane

Internal ear (labyrinth)

Consists of a series of cavities channeled out of the temporal bone called osseous labyrinth; lined by a thin fibro-serous membrane which secretes perilymph; in this floats a sac called membranous labyrinth

A—Osseous labyrinth

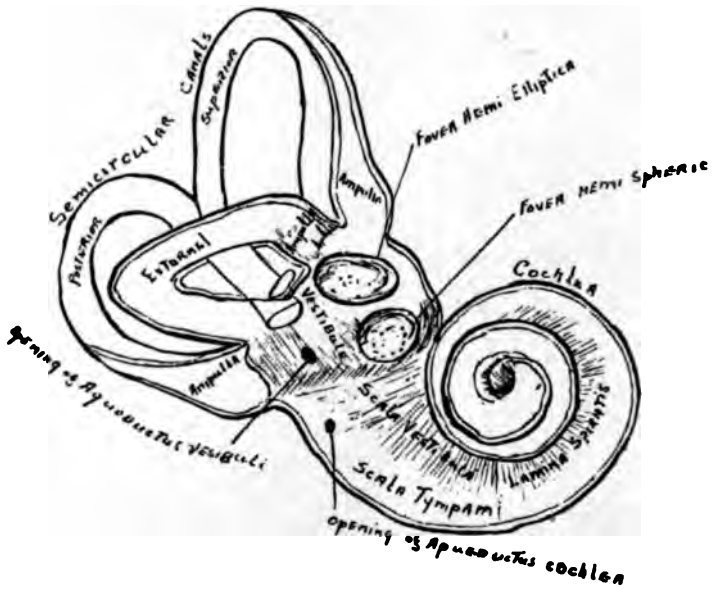


FIG. 226.—Bones of Tympanum

a—Vestibule

The main cavity of the labyrinth communicates anteriorly with the scala vestibuli, posteriorly by five openings with the semi-circular canals

Outer wall

Opening called fenestra vestibula (ovale)

Inner wall

A—Recessus sphericus (hemispherica) corresponds to saccule

B—Macula cribrosa openings for vestibular nerve

C—Pyramidal eminence, eminence which separates fovea from aqueduct vestibuli

Roof

Shows

a—Recessus sphericus (hemispherica)

b—Pyramidal eminence

c—Recessus ellipticus corresponds to semicircular canals

Three in number

a—Superior canal

Lies at right angles to the petrous portion of the temporal bone

b—Posterior canal

Lies parallel to the petrous bone

c—External canal

Horizontally outward and backward. Each canal shows a dilated portion called ampulla. Superior and posterior canal join

Cochlea

Excavation in the petrous portion of the temporal bone. Base corresponds to the bottom of the internal auditory meatus. Apex forward and outward

Shows

a—Modiolus. Central axis of the cochlea

b—Spiral canal, space between modiolus and outer wall of the cochlea; takes two and one-half turns above. Modiolus terminates in cul-de-sac called cupola. Which communicates with

1—Fenestra cochlearis (Rotunda)

2—Cavity of the vestibule

3—Cochlear aqueduct

c—Lamina spiralis

Bony projection which separates spiral canal and consists of two layers between which the cochlear nerve passes

d—Scala tympani

That portion of the spiral canal that lies below the lamina spiralis

e—Scala vestibulae

Above lamina spiralis and membrana basilaris

f—Scala media

Triangular portion above the

lamina spiralis. Separated from scala vestibule by membrane of Reissner. Shows organ of Corti

Membranous labyrinth

Closed sac within the osseous labyrinth prolonged into semicircular canals and lining the vestibular portion. Two sacs called saccule and utricle. Saccule lies in relation with the recessus sphericus

Utricle lies in recessus sphericus

Membranous semicircular canals

One-half the size of the osseous canal opens into utricle by five canals

Membranous labyrinth filled with endo-lymph separated from the osseous labyrinth by perilymph

Nerves

Vestibular division to

Ampulla, utricle and saccule

Cochlear division to

To the lamina spiralis and the organ of Corti

Arteries

Auditory artery (a branch of the basilar artery)

Stylo-mastoid artery (a branch of the posterior auricular artery)

Petrosal (branch of the middle meningeal artery)

GLOSSARY

SENSE ORGANS

BASLE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
EYE	
Sclera	Sclerotic coat
Lamina elastica anterior (Bowmani)	Bowman's membrane
Lamina elastica posterior (Descemeti)	Descemet's membrane
Spatia anguli iridis	Spaces of Fontana
Angulus iridis	Iridio-corneal junction
Zonula ciliaris	Zonule of Zinn
Septum orbitale	Palpebral ligament
Fascia bulbi	Capsule of Tenon
Commissura palpebrarum (lateralis)	External canthus

LE ANATOMICAL TERMINOLOGY	OLD TERMINOLOGY
Commissura palpebrarum medialis	Internal canthus
Tarsus superior	Superior tarsal plate
Tarsus inferior	Inferior tarsal plate
Lig. palpebrale mediale	Internal tarsal ligament
Raphe palpebralis lateralis	External tarsal ligament
Tarsal glands	Meibomian glands
EAR	
Canalis semicircularis lateralis	External semicircular canal
Ductus reuniens	Canalis reuniens
Ductus cochlearis	Membranous cochlea
Recessus sphaericus	Fovea hemispherica
Recessus ellipticus	Fovea hemi-elliptica
Paries jugularis	Floor of tympanum
Paries labyrinthica	Inner wall
Fenestra vestibuli	Fenestra ovalis
Fenestra cochleae	Fenestra rotunda
Paries mastoidea	Posterior wall
Antrum tympanicum	Mastoid antrum
Paries carotica	Anterior wall
Processus lateralis	Processus brevis of malleus
Processus anterior	Processus gracilis

SKIN

EPIDERMIS

Composed of five layers; from without, are

1—Stratum corneum
Stratified non-nucleated epithelial cells

2—Stratum lucidum
Closely packed epithelial cells

3—Stratum granulosum
Spindle-shaped cells containing eleiden crystals

4—Stratum of prickle cells

5—Stratum mucosum (malpighii) covering the papilla

DERMIS

Capillary layer, next to the epidermis covered with minute conical elevations containing the capillary loop of the vessels, nerves and special endings, such as tactile corpuscles

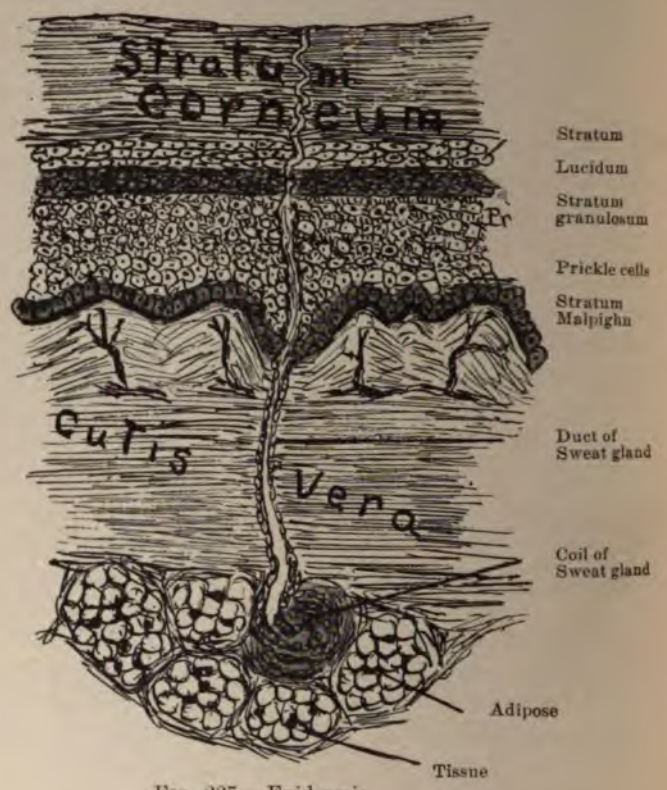


FIG. 227.—Epidermis

Reticular layer

Interlacing bundles of connective fibrous tissue, blood vessels and nerves

Structures in the skin

1—Sensitive papillae

2—Hair follicles

3—Sebaceous glands

4—Sudoriferous glands (sweat glands)

5—Meibomian glands

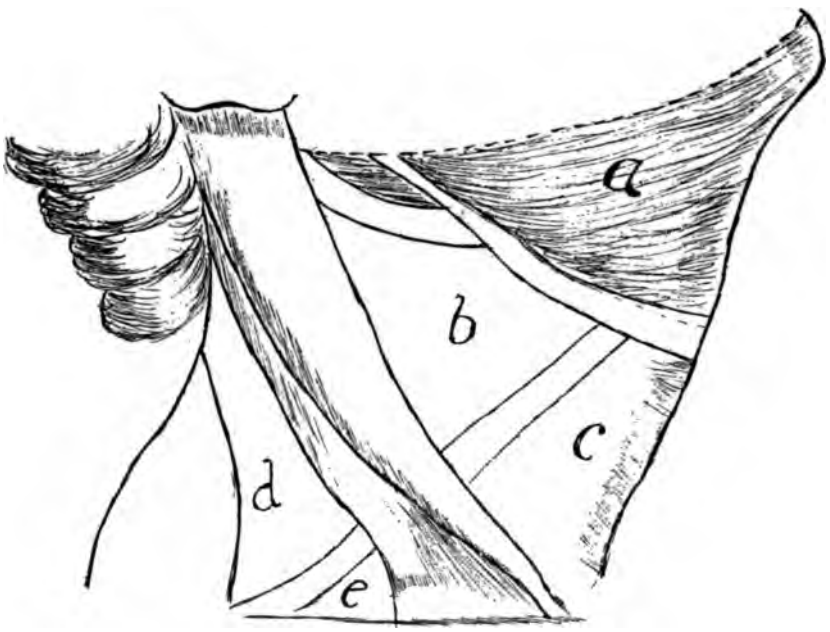
Sebaceous glands each consisting of a straight follicle, with numerous small secondary follicles opening into it. They are about thirty on each lid; occupying the inner surface of the eyelids. Between the tarsal plate and the conjunctiva. The ducts open on the free margin of the lids. The secretion prevents adhesion of the lids

SURGICAL ANATOMY

TRIANGLES AND SPACES

TRIANGLES OF THE NECK

The neck is a quadrilateral space bounded above by the lower margin of the mandible and an imaginary line from angle to mastoid process. In front bounded by median line of the neck. Behind by trapezius muscle, below by the clavicle. Divided into two triangles by the sterno cleido mastoid, base of the anterior triangle upward and base of the posterior triangle down



a—Submaxillary triangle
b—Superior carotid triangle
c—Inferior carotid triangle
d—Sub-occipital triangle
e—Subclavian triangle

FIG. 228.—Triangles of the Neck

Anterior triangle is again divided into

A—Muscular (inferior carotid triangle) triangle of necessity

a—Boundaries

1—In front by the median line of the neck

2—Behind, by anterior margin of the sterno-cleido mastoid muscle

3—Above by the anterior border of the omohyoid muscle

4—Floor is formed by the longus colli and scalenus anterior muscle

b—Contents

1—Arteries

A—Common carotid
B—Inferior thyroid
C—Vertebral

2—Veins

A—Internal jugular
B—Vertebral
C—Middle thyroid

3—Nerves

A—Superficialis colli; branch of the cervical plexus
B—Vagus
C—Descending hypoglossi (branch of the cervical plexus)
D—Ansa hypoglossi (branch of the cervical plexus)
E—Recurrent laryngeal (branch of vagus and sympathetics)

4—Organs

A—Trachea
B—Thyroid gland
C—Lower part of larynx

B—Carotid triangle (superior carotid)

a—Boundaries

1—Above by posterior belly of digastric muscle
2—Behind by the sterno-cleido-mastoid
3—Below by the anterior belly of the omohyoid muscle
4—Floor is formed by

Hyo-glossus muscle
Thyro-hyoid muscle
Middle constrictor muscle
Superior constrictor muscle

b—Contents

Arteries

A—Common carotid (bifurcation)
B—External carotid
C—Internal carotid
D—Superior thyroid
E—Lingual

G—Occipital
H—Ascending pharyngeal

Veins
A—Internal jugular
B—Superior thyroid
C—Lingual
D—Facial
E—Occipital
F—Pharyngeal

Nerves
A—Facial branches (cranial)
B—Cutaneous colli (branch of cervical plexus)
C—Descending hypo-glossal (branch of hypo-glossal)
D—Hypoglossal (cranial)
E—Vagus (cranial)
F—Spinal accessory (cranial)
G—Superior laryngeal (branch of vagus)
H—External laryngeal (branch of superior laryngeal)

Organs
A—Lower part of pharynx
B—Upper part of larynx

c—Digastric triangle (submaxillary)

a—Boundaries
1—Above by the lower border of jaw, the parotid gland and the mastoid process
2—Behind by the posterior belly of the digastric and the stylo-hyoid muscles
3—Front by the middle line of the neck
4—Floor is formed by
Anterior belly of the digastric
Mylo-hyoid
Hyo-glossus

b—Contents
Arteries
A—Interior carotid
B—External carotid
C—Facial
D—Sub-mental
E—Mylo-hyoid
F—Posterior auricular

G—Temporal
H—Internal maxillary

Veins
A—Internal jugular
B—Facial
C—Parotid veins
D—Temporal
E—Internal maxillary
F—Temporo maxillary
G—Posterior auricular

Nerves
A—Facial
B—Vagus
C—Mylo-hyoid
D—Glosso-pharyngeal
E—Superficial cervical

Glands
A—Submaxillary gland
B—Parotid gland

Posterior triangle is again divided into

A—Occipital triangle

a—Boundaries

1—In front by the posterior margin of the sterno cleido-mastoid
2—Behind by trapezius muscle
3—Below by posterior belly of omo-hyoid muscle
4—Floor is formed by
Splenius
Levator scapulae
Scalenus medius
Scalenus posterior

b—Contents

Arteries
A—Transversalis colli

Veins
A—Transversalis colli
B—Posterior external jugular

Nerves
A—Ascending branches of the cervical plexus
B—Spinal accessory
C—Descending branches of the cervical plexus

Glands
A—A chain of lymphatics running from the

mastoid process to the root of the neck

B—Subclavian triangle

a—Boundaries

1—Above by posterior belly of the omo-hyoid

2—Below by the clavicle

3—Front by posterior margin of the sterno-cleido-mastoid muscle

b—Contents

Arteries

A—Subclavian (third portion)

B—Supra clavicular

C—Transversalis colli

Veins

A—Subclavian (occasionally)

B—Supra-scapular

C—Transversalis colli

D—External jugular

E—Small vein crossing the middle of the clavicle from the cephalis vein

Nerves

A—Descending branches of the cervical plexus

B—Brachial plexus formed by fifth, sixth, seventh, eighth, cervical and first thoracic nerves

C—Nerve to the subclavian muscle

Glands

A—Lymphatic glands

TRIANGLE IN FRONT OF THE ELBOW JOINT

Boundaries

Externally

Brachio-radialis (supinator longus)

Internally

Pronator teres

Above (base)

Imaginary line two inches above the condyles of humerus

Covered

Skin, superficial fascia, inter-tubercular fascia

Floor

Brachialis

Supinator (brevis)

Contents

From within outward

Median nerve
Brachial artery
Vena comites
Tendon of biceps
Radial nerve (musculo-spiral)

FEMORAL TRIANGLE (SCARPA'S)

Boundaries
Above
Inguinal ligament
Internally
Adductor longus muscle
Externally
Sartorius muscle
Floor is formed from without inwards by
Iliacus
Psoas
Pectineus
Adductor longus
Adductor brevis

Contents
1—Femoral artery which runs from its base to its apex
2—Femoral vein, which at the upper part of the triangle lies upon the inner side of the artery, but lower down upon the posterior aspect of the vessel
3—The femoral and saphenous nerves, which lie upon the outer side of the artery
4—Internal cutaneous nerve and branches of the genito-femoral nerve which lies in front of the artery

Memorized by the word "navel":—nerve, artery, vein, empty space, lymphatics (structures from without, inward)

HESSELBACH'S TRIANGLE

Definition
Two triangles on either side of the median wall on lower anterior surface of the abdominal wall

Boundaries
Externally
Inferior epigastric artery (deep epigastric)
Internally
Rectus abdominis
Below
Inguinal ligament (Poupart's)

TRIANGLES

A—GROCCO'S TRIANGLE

Definition

Presence of a triangular area of dullness on the back on side opposite to pleural effusion (sign indicating pleural effusion)

B—LESSER'S TRIANGLE

Definition

Triangle formed by hypoglossal nerve above and two bellies of the digastric on either side

C—MACEWEN'S SUPRAMEATAL TRIANGLE

Definition

Triangular area between lower posterior edge of the root of the zygoma and the superior posterior edge of the external acoustic meatus

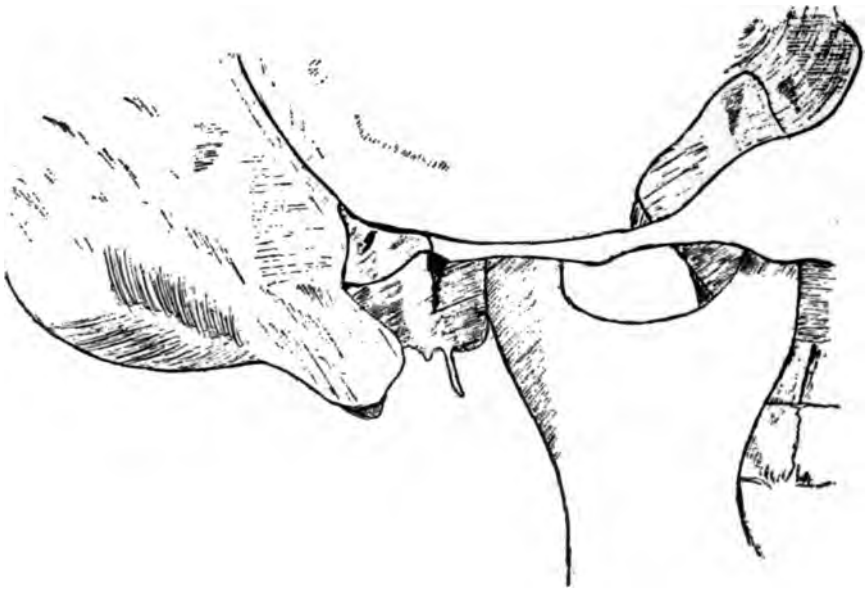


FIG. 229.—Macewen's Suprameatal Triangle

D—TRIANGLE OF PETIT

Definition

Triangle bounded by crest of the ilium below external oblique and latissimus dorsi on either side

SPACES

A—AXILLARY SPACE

Definition

The axilla or the axillary space, through which the axillary artery passes. Is pyramidal in form, its apex being above and its base corresponding to the integument and fascia which binds the arm to the side of the trunk. This space is situated between the arm and the lateral wall of the chest, and is covered in front by the pectoral muscles

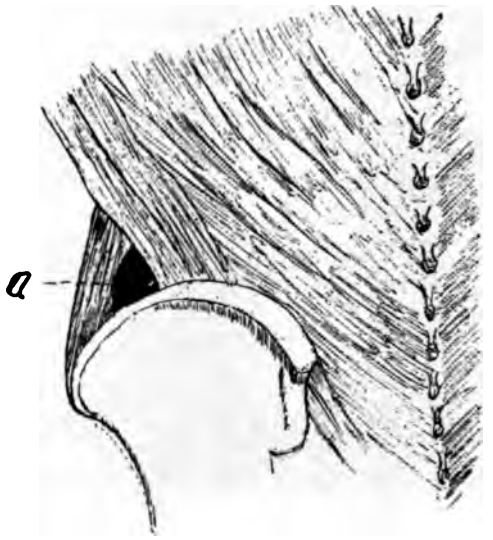


FIG. 230.—Petit Triangle

Boundaries

1—Front

Muscles

Pectoralis minor

Pectoralis major

Costo-coracoid membrane

2—Behind

Muscles

Teres major

Latissimus dorsi

Subscapularis

3—Internally

The first, second, third and fourth ribs

Muscles

a—First four intercostals

b—Serratus magnus

4—Externally

Muscles

a—Coraco-brachialis

b—Biceps brachii

Humerus

Contents

1—Arteries

Axillary artery and its branches

a—Superior thoracic

b—Acromial thoracic

c—Long thoracic

d—Alar thoracic

e—Subscapular

f—External circumflex

g—Internal circumflex

2—Veins

Axillary

Cephalic

Several veins corresponding to the arterial branches above mentioned

3—Nerves

Brachial plexus (the three cords)

Medial anterior thoracic

Lateral anterior thoracic

Medial cutaneous

Lateral cutaneous (musculo-cutaneous)

Ulnar

Median

Radial

Axillary

Three subscapular

Posterior thoracic nerve

Intercostal brachialis nerve

4—Glands

5—Abundant fat and areolar tissue

3—*POPLITEAL SPACE*

Definition

A lozenge-shaped space on the back of the knee

Boundaries

Internally

Above

Semimembranosus

Below
Medial head of the gastrocnemius muscle and medial condyle of the femur

Externally
Above
Biceps femoris
Below
Outer head of gastrocnemius muscle, plantaris muscle and lateral condyle of femur

Floor
This space is formed by the posterior surface of the femur, the posterior ligament of the knee joint, the popliteus muscle and the upper part of the tibia

Contents
Contains the popliteal artery, popliteal vein and the tibial nerve. The peroneus communis nerve, the small sciatic nerve, the articular branch of the obturator nerve, the saphenous parva vein, lymphatic glands, adipose tissue
The relations of the important parts contained within this space are as follows
A—The popliteal artery lies nearest to the floor
B—The popliteal vein lies superficial to the artery and slightly external to it
C—The tibial nerve (internal popliteal) lies superficial to the vein and slightly external to it
D—The peroneus communis (external popliteal nerve) lies close to the tendon of the biceps muscle

Mediastinum
This is the space in the middle line of the thorax formed by the approximation of the pleura on either side, and extends from the sternum in front to the bodies of the vertebrae behind
A—Divided into three portions
a—Anterior
b—Middle
c—Posterior
B—Boundaries and contents
a—Anterior mediastinum
Boundaries
Front
Sternum
Behind
Pericardium
Laterally
Pleurae

Contents

Origin of the sterno-hyoideus muscles, origin of sterno-thyroideus muscles, triangularis sterni muscle; left internal mammary artery and venae comites (the right internal mammary vessels being covered by pleura are not included among the contents of the space). Remains of the thymus gland; lymphatic vessels from convex surface of liver and loose areolar tissue

b—Middle mediastinum

Boundaries

Front

Anterior mediastinum

Behind

Posterior mediastinum

Laterally

Pleurae

Contents

The heart enclosed in pericardium. Ascending portion of the aorta; superior vena cava; bifurcation of trachea; pulmonary artery and veins. Phrenic nerves (from third, fourth, and fifth cervical); arteriae comites nervi phrenica (from internal mammary)

c—Posterior mediastinum

Boundaries

Front

Pericardium and root of the lungs

Behind

Vertebral column

Pleurae

Contents

Descending aorta; azygos (major) hemiazygos (minor); superior intercostal veins; vagus nerves; greater splanchnic nerves; esophagus; thoracic duct and lymphatic glands and vessels

CIRCULATION

RCLE OF WILLIS

Definition

An anastomosis between the vessels of the base of the brain

by means of which the circulation of the brain is equalized This anastomosis, which is known as the circle of Willis, results from a series of communications between the following arteries

a—The anterior cerebral arteries, which assist in forming the circle, are direct branches of the internal carotid artery of either side

b—The two anterior cerebral arteries are connected by the anterior communicating artery

c—The internal carotid arteries of each side are united to the two posterior cerebral arteries by the posterior communicating branches

d—The posterior cerebral arteries themselves arise from a single trunk, *viz.*, the basilar artery

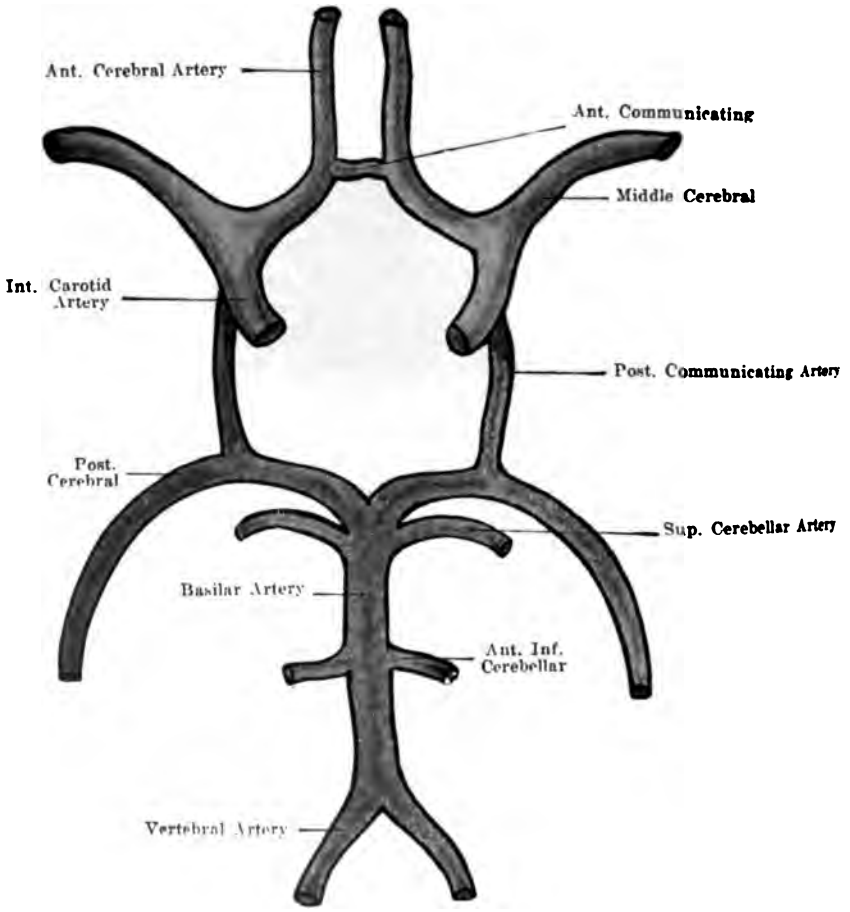


FIG. 231.—Circle of Willis

Within the space of this vascular circle may be found from before backwards

a—Lamina cinerea
b—Optic commissure
c—Infundibulum
d—Tuber cinereum
e—Corpora albicantia
f—Posterior perforated space

COLLATERAL CIRCULATION AFTER LIGATION

A—ABDOMINAL AORTA

I—Internal mammary (branch of subclavian) with the deep epigastric (branch of external iliac)

II—Lumbar arteries (branch of aorta) with ilio-lumbar (branch of internal iliac)

III—Branches of the superior mesenteric (with branches of inferior mesenteric)

IV—Branches of the inferior mesenteric with branches of the internal pudic

B—COMMON ILIAC

I—The anastomoses of the hemorrhoidal branches of the internal iliac with the superior hemorrhoidal branch of the inferior mesenteric

II—The anastomoses of the uterine and ovarian arteries and of the vesicle arteries of the opposite side

III—The lateral sacral with the middle sacral artery

IV—Epigastric artery with the internal mammary inferior intercostal and lumbar arteries

V—Ilio-lumbar with the last lumbar artery

VI—The obturator artery, by means of its pudic branch with the vessel of the opposite side and with the internal epigastric

VII—The gluteal with the posterior branches of the sacral arteries

C—EXTERNAL ILIAC

I—Ilio-lumbar with the circumflex iliac

II—Gluteal with the external circumflex

III—Obturator, with the internal circumflex

IV—Sciatic with the profunda femoris

V—Internal pudic with the external pudic, and with the internal circumflex

D—INTERNAL ILIAC

I—Anastomosis of the uterine and ovarian arteries
II—Anastomosis between opposite vesical arteries
III—Hemorrhoidal branches of the internal iliac with those from the inferior mesenteric
IV—Obturator artery, by means of its pudic branch with the vessel of the opposite side, and with the epigastric and internal circumflex
V—The circumflex and perforating branches of the femoral with the sciatic
VI—Gluteal with the posterior branches of the sacral arteries
VII—Ilio-lumbar with the last lumbar
VIII—Lateral sacral with the middle sacral
IX—Circumflex iliac with the ilio-lumbar and gluteal

E—INNOMINATE ARTERY

The arteria innominata if tied no longer furnishes blood to the right side of the head or to the right upper extremity. Certain indirect channels are therefore forced to carry an additional amount of blood to supply these parts with proper nutrition

1—A regurgitant current through the circle of Willis by means of the left carotid and vertebral arteries, which fills the vessels of the right side immediately after the application of the ligature
2—The carotids of both sides anastomose, by means of their branches which meet in the median line. These branches are as follows
A—Superior thyroid arteries
B—Lingual arteries
C—Facial arteries
D—Internal maxillary arteries
E—Occipital arteries
F—Temporal arteries
3—The subclavian artery derives blood directly from the anastomosis of the following vessels
Superior intercostal with first aortic intercostal
Profunda cervicis with princeps cervicis
Lower intercostals with internal mammary branches
Lower intercostals with axillary branches
Internal mammary with deep epigastric artery
The two inferior thyroid arteries with each other

F—SUBCLAVIAN ARTERY

I—Receives blood from the circle of Willis through cerebral artery

II—Receives blood from the carotid through superior thyroid artery
III—Receives blood from carotid through princeps cervicis artery
IV—Receives blood from thoracic aorta through the posterior intercostals
V—Receives blood from external iliac through the deep epigastric artery

G—BRACHIAL ANASTOMOSIS

If the ligature is applied above the origin of the profunda brachii (superior profunda)

The posterior circumflex and the subscapular by anastomosing with ascending branches of profunda carry on the circulation

If the ligature is applied below the origin of the superior profunda

The profunda brachii (superior profunda) and its branches anastomose with the recurrent branches of the radial, ulnar and interosseous and thus carry on the circulation

H—ARTERIAL ANASTOMOSIS ABOUT THE KNEE-JOINT

I—Superior lateral genu (superior external articular) artery

Anastomoses with the descending branch of the circumflex femoris lateralis (external circumflex), the inferior lateral genu (inferior external articular), the genu suprema (anastomotic magna) and the superior medial genu (superior internal articular)

II—Superior medial genu (superior internal articular artery)

Anastomoses with the anastomotica magna, the inferior medial genu (inferior internal articular) and the superior external articular

III—The inferior lateral genu (inferior external articular) artery

Anastomoses with the inferior medial genu (inferior internal articular). The superior lateral genu (superior external articular) and the anterior recurrent branch of the anterior tibial

IV—The inferior internal articular artery

Anastomoses with the inferior lateral genu (inferior external articular) and the superior medial genu (superior internal articular). The whole forms a superficial and deep plexus; the former being situated between the fascia and skin around the patella, and the latter on the articular surfaces of the lower end of the femur and the upper end of the tibia

I—VEINS WITHOUT VALVES

I—Venae cavae
II—Hepatic
III—Portal and its branches
IV—Renal

V—Uterine
VI—Ovarian
VII—Pulmonary
VIII—Cerebral
IX—Spinal
X—Umbilical
XI—The sinuses of the skull and very small veins are also without valves

PALMAR ARCHES

A—SUPERFICIAL VOLAR ARCUS (SUPERFICIAL PALMAR ARCH)

Definition

An arch formed by the ulnar anastomosing with the superficial volar of the radial

Location

A line drawn across the palm of the hand at point where web of thumb joins the hand

Branches

Four digital

B—ARCUS VOLAR PROFUNDA (DEEP PALMAR ARCH)

Definition

Formed by the radial artery anastomosing with a deep branch of the ulnar

Location

Transversely across the palm one-half inch nearer the wrist at junction of carpal with the metacarpal bones

Branches

Palmar interosseous
Perforating
Palmar recurrent

CANALS

CRURAL OR FEMORAL CANAL

DEFINITION

Funnel shaped interval in femoral sheath one-half to one and one-half inches long from lacunar (gimbernats) ligament to saphenous opening

BOUNDARIES

Anterior wall

Transversalis fascia

Inguinal (Poupart's ligament)
Posterior wall
Iliac fascia
Fascia lata
Outer wall
Septum of femoral sheath
Inner wall
Transversalis and iliac fascia
Upper orifice
Closed by septum femoral (crural) and gland
Lower orifice
Saphenous opening covered by cribriform fascia

COVERINGS

I—Integument
II—Superficial fascia
III—Cribriform fascia
IV—Femoral sheath
V—Septum femoral (crural)
VI—Areolar tissue and fat
VII—Peritoneum

THE INGUINAL CANAL

DEFINITION

Is one and one-half inches in length and extends from the abdominal inguinal ring (internal abdominal ring) to the subcutaneous inguinal ring (external abdominal ring)

In front
A—Skin
B—Superficial fascia
C—External oblique muscle for its entire length
D—Internal oblique muscle for its outer third
Behind
A—Falx aponeurotica inguinalis (conjoined tendon of the internal oblique and transversalis muscle)
B—Transversalis fascia
C—Cremasteric fascia (triangular ligament)
D—Subperitoneal tissue and fat
E—Peritoneum
Above
A—Fibers of internal oblique muscle
B—Fibers of transversalis abdominis muscle

Below

A—Inguinal (Poupart's ligament)

B—Transversalis fascia

This canal lies parallel with inguinal (Poupart's) ligament and is directed downwards and inwards. Its extremities are named respectively the abdominal inguinal ring (internal abdominal ring) and the subcutaneous inguinal ring (external abdominal ring). It transmits the spermatic cord in the male and the round ligament in the female

Coverings of Inguinal Hernia

A—Skin

B—Superficial fascia

C—Intercolumnar fascia

D—Cremasteric fascia

E—Infundibuliform fascia

F—Preperitoneal fat

G—Peritoneum

ALCOCK'S CANAL

DEFINITION

The fascial sheath of the internal pudic artery

ADDUCTOR CANAL (HUNTER'S CANAL)

DEFINITION

An opening in the adductor magnus

BOUNDARIES

Externally

By vastus medialis (internus)

Internally

By adductor magnus

Anteriorly

These muscles are connected by fascia upon which the sartorius muscle rests

CONTENTS

Femoral vessels

Internal saphenous nerve

CANAL OF NUCK

DEFINITION

Tubule of peritoneum descending from uterus into the inguinal canal

OPENINGS

A—FEMORAL RING

This opening is oval in shape, is one-half of an inch in breadth and is situated underneath the Inguinal (Poupart's) ligament, internal to the femoral vessels

It has the following boundaries

Above

Inguinal (Poupart's) ligament
Deep femoral (crural) arch

Below

Pubic bone
Pectineus muscle
Iliac fascia
Pubic portion of fascia lata

Internally

Lacunar (Gimbernat's) ligament
Falx aponeurotica inguinalis (conjoined tendon)
Deep femoral (crural) arch
Transversalis fascia

Externally

Femoral vein and septum

From the space outwards, we find in the normal condition the following structures in this order

A—Lacunar (Gimbernat's) ligament
B—Femoral opening
C—Femoral vein
D—Femoral artery
E—Femoral (anterior crural) nerve

B—ABDOMINAL INGUINAL RING (INTERNAL ABDOMINAL RING)

Oval opening in the transversalis fascia midway between the anterior, superior, spine and the pubes, ½ inch above inguinal (Poupart's) ligament. Bounded above and externally by the transversalis-abdominalis muscle, below and internally by the deep epigastric vessels. Transmits the spermatic cord in the male and the round ligament in the female covered by the infundibuliform fascia

C—SUBCUTANEOUS INGUINAL RING (EXTERNAL ABDOMINAL RING)

Definition

A triangular opening in the aponeurosis of external oblique immediately above and just external to crest of os pubes

Boundaries

Inferiorly

By crest of os pubes

Superiorly

Intercolumnar fibers, strengthened by intercolumnar fascia

Internally

Inner or superior crus (pillar)

Externally

By outer or inferior crus (pillar)

Transmits

Spermatic cord in male and round ligament in female

D—OPENINGS IN THE ABDOMINAL WALL

There are ten openings in the abdominal wall in the male and eleven openings in the female. These openings may be classified

1—Upwards through the diaphragm

Esophageal

A muscular opening on level of ninth dorsal vertebra transmitting

1—Esophagus

2—Vagus (pneumogastric) nerve

Aortic

A tendinous opening on level with twelfth dorsal vertebra transmitting

1—Aorta

2—Vena azygos

3—Thoracic duct

Caval

Opposite the ninth dorsal vertebra transmitting

1—Vena cava ascendens

2—Forwards

Umbilicus

Abdominal inguinal rings

Femoral rings

3—Downwards

For urethra

For rectum

For vagina in female

LIGAMENTS AND FASCIA

INGUINAL (POUPART'S LIGAMENT)

This ligament is formed by the lower fibers of the aponeurosis of the external oblique muscle, and extends from the anterior superior spine of the ilium to the spine of the pubes

LACUNAR (GIMBERNAT'S) LIGAMENT

This ligament is a reflection of fibers derived from Poupart's ligament, backwards and inwards to the ilio-pectineal line

PALMAR FASCIA

The fascia composed of a central and two lateral portions the central segment, triangular in front. Attached to transverse carpal ligament (annular ligament) divides into four slips opposite the head of the metacarpal bone. Each slip divided into two to enclose the flexor tendon. Lateral portion of fascia invests the muscles of the thenar and hypothenar muscles

LINEA ALBA

Is a tendinous raphé in the middle line of the abdomen from the xiphoid (ensiform) to the pubes. It is formed by the blending of the oblique and transversalis abdominalis muscle

BUNDLE OF HIS

Definition

A bundle of muscular fibers extending from right interauricular septum to the interventricular septum represents the pathway of transmission of impulse from auricle to ventricle

FASCIA LATA

Fascia lata of the thigh envelops the muscles and surrounds the limb. Above it is attached to the back of the sacrum and coccyx to the iliac crest to inguinal (Poupart's) ligament, pubic body and ramus, ischial tuberosity and ramus, and to the lower edge of the tuberous (great sacro-sciatic) ligament. The ilio-tibial band is a thickened part attached above to the iliac crest and below to the head of the fibula and outer tuberosity of the tibia. The fascia lata is attached below to the head of the tibia and sides of the patella, being strengthened by aponeuroses from the vasti muscles. Behind, the fascia passes across between the hamstring muscles, enclosing the popliteal space

PERINEUM

Definition

Outlet of pelvis which lies anteriorly to line drawn between tuberosities of ischium

Anatomy

Triangular in shape

Bounded

Anteriorly, symphysis pubis

Laterally rami of pubes and ischium

Posteriorly by line between tuber ischii

Width

Three inches

Composed

Integument

Anal group of muscles

a—Sphincter

b—Levator ani

c—Coccygeus

Genito-urinary group of muscles

a—Accelerator urinae

b—Erector

c—Transversus perinei-superficialis

d—Sphincter urethra membranosa (compressor urethra)

Fasciae

a—Superficial perineal

Superficial layer

Deep layer

b—Urogenital diaphragm (deep perineal or triangular ligament)

Anterior layer

Posterior layer

c—Buck's fascia

d—Pelvic fascia

Obturator fascia

Oschio-rectal fascia

Lateral lithotomy

Parts divided

1—Integument

2—Superficial fascia

3—Inferior hemorrhoidal vessels and nerves

4—Superficial perineal vessels and nerves

5—Transversus perinei superficialis muscle

6—Accelerator urinae muscle (posterior fiber)

7—Urogenital diaphragm (deep perineal fascia) anterior layer
8—Sphincter of urethral membrane (compressor urethrae muscle)
9—Levator ani muscle anterior fibers
10—Membranous and prostatic portions of urethra
11—Prostate gland and posterior layer of the deep perineal fascia

MUSCLES

A—MUSCLES OF MASTICATION

I—Temporal
II—Internal pterygoid
III—External pterygoid
IV—Masseter
V—Buccinator

B—MUSCLES OF DEGLUTITION

I—Buccinator
II—Hypoglossus
III—Styloglossus
IV—Palpatoglossus
V—Palatopharyngeus
VI—Azygos uvulae
VII—Tensor palati
VIII—Levator palati
IX—Stylopharyngeus
X—Stylohyoid
XI—Geniohyoid
XII—Mylohyoid
XIII—Thyrohyoid
XIV—Digastric
XV—Constrictors of pharynx
XVI—Intrinsic muscles of the tongue

C—INTERNAL HAMSTRING COMPOSED

I—Semitendinosis
II—Semimembranosis
III—Gracillis

D—MUSCLES THAT FORM THE QUADRICEPS FEMORIS (EXTENSOR)

I—Rectus femorus
II—Vastus lateralis (externus)
III—Vastus medialis (internus)
IV—Vastus intermedius (crureus)

E—MUSCLES OF THE CALF OF THE LEG

I—Gastrocnemius
II—Soleus
III—The tendons of soleus and gastrocnemius unite to form the tendocalcaneus (tendon Achilles) which is inserted into os calcis

F—MUSCLES ATTACHED TO GREAT TROCHANTER OF FEMUR

I—Gluteus medius and minimus
II—Pyreformis
III—Obturator internus and externus
IV—Superior and inferior gemelli

G—EXTERNAL ROTATORS OF THE THIGH ARE

I—Obturator externus
II—Obturator internus
III—Gemellus superior
IV—Gemellus inferior
V—Gluteus maximus
VI—Gluteus medius and minimus
VII—Pyriformis
VIII—Quadratus femoris
IX—Adductor longus
X—Adductor magnus
XI—Adductor brevis
XII—Pectineus
XIII—Ilio-psoas
XIV—Sartorius

H—INTERNAL ROTATORS OF THE THIGH

I—Tensor fascia lata (tensor vaginae femoris)
II—Gluteus medius and minimus

I—MUSCLES ATTACHED TO THE GREATER TUBEROSITY OF THE HUMERUS

I—Supraspinatus

II—Infraspinatus
III—Teres minor muscle

J—MUSCLES ATTACHED TO THE LESSER TUBEROSITY

I—Subscapularis

Between these two tuberosities there passes the long tendon of biceps

FOSSA

ISCHIORECTAL FOSSAE AND THEIR CONTENTS

Definition

A fossa situated between the lower end of the rectum and the tuberosity of the ischium. The space is triangular in shape

Base

Downward, formed by the integument of the ischiorectal region

Apex

Upward and corresponds to the point of division of the obturator fascia and anal fascia

Internal Boundary

Formed by the tuberosity of the ischium and obturator fascia covering the obturator internus muscle; the space is limited in front by the line of junction of the superior and deep perineal fasciae, behind by the margin of the gluteus maximus muscle and sacro-tuberous (great sacro-sciatic) ligament

In the outer wall of the fossa the internal pudic vessels and nerve are inclosed in a sheath of obturator fascia (Alcock's canal). The ischiorectal space is filled with adipose tissue and crossed anteriorly by the superficial perineal vessels and nerves, in the middle by the inferior hemorrhoidal vessels and nerve, posteriorly by the fourth sacral nerve

NASAL FOSSAE

They are two large, irregular cavities, situated on each side of the middle line of the face. Extend from the base of the cranium to the roof of the mouth, and are separated from each other by a thin vertical septum. They communicate with the face by the two anterior nares and with the pharynx by the two posterior nares

The roof is formed by the following bones

A—Nasal

B—Cribriform plate of ethmoid

C—Body of the sphenoid
D—Sphenoidal process of the palate
E—Ala of the vomer

The floor
A—Palatal process of the maxilla
B—Palate bones

Inner wall
A—Septum
a—Consisting of the crest of the nasal bone
b—The nasal spine of the frontal
c—Perpendicular plate of the ethmoid
d—Vomer
e—Rostrum
f—Ethmoidal crest of the sphenoid

Outer wall
A—Nasal bone
B—Nasal process of the maxilla
C—Lacrimal
D—Ethmoid
E—Superior maxilla
F—Inferior concha (turbinated)
G—Pars perpendicular (vertical plate) of the palate
H—Medial lamina pterygoid process (internal pterygoid plate of the sphenoid

It has three longitudinal passages (meatus)

Superior
Situated between the superior and middle concha (turbinate); opening into it are the sphenopalatine air-cells and the posterior ethmoidal cells

Middle
Between the middle and inferior concha (turbinate bones), opening into it are the antrum and infundibulum

Inferior
Between the inferior concha (turbinate) and the floor of the nasal cavity; opening into it is the nasal duct

POINTS WORTH REMEMBERING

LARGEST ARTERY ..... *ABDOMINAL AORTA*
LARGEST NUTRIENT ARTERY..... *TIBIAL*
LARGEST SYNOVIAL MEMBRANE..*AT THE KNEE JOINT*
LARGEST MUSCLE ..... *GLUTEUS MAXIMUS*

LARGEST NERVE ..... *ISCHIADICUS (SCIATICUS MAGNUS)*
LARGEST VEIN ..... *VENA CAVA*
LONGEST MUSCLE ..... *SARTORIUS*
LONGEST TENDON ..... *PLANTARIS*
BRANCHLESS ARTERY .....

Common carotid (except the terminal branches). There are also no branches from the cervical portion of the internal carotid

VEINS CARRYING ARTERIAL BLOOD

Pulmonary

In the fetus the veins carrying arterial blood are the umbilical hepatic and inferior vena cava

ARTERY CARRYING VENOUS BLOOD

Pulmonary

In the fetus umbilical also carries venous blood

NERVE PERFORATED BY AN ARTERY

Sciatic by the comes nervi ischiadici; the arteria centralis retinae also pierces the optic nerve

NERVE PERFORATED BY A VEIN

Those just named

MUSCLE PERFORATED BY A MUSCLE

Stylo-hyoid by the digastric

MUSCLE PERFORATED BY A NERVE

Occasionally the axillary vein by the medial (internal) anterior thoracic nerve

LIGAMENT PERFORATED BY A NERVE

Sacro-sciatic by the anterior branch of the coccygeal nerve

LIGAMENT PIERCED BY AN ARTERY

The greater sacro-tuberous (sacro-sciatic), by the coccygeal branch of the sciatic artery. The azygos articularis artery also pierces the posterior ligament of the knee-joint

MEMBRANE PIERCED BY AN ARTERY

The thyro-hyoid by the superior laryngeal artery

TENDONS PERFORATED BY TENDONS

These are the flexor sublimis digitorum of the hands for the passage

of the tendons of the flexor profundus digitorum. In the foot, the tendons of the flexor brevis digitorum are split for the passage of the tendons of the flexor longus digitorum

LARGEST BRANCH OF THE INTERNAL CAROTID ARTERY

Is the middle cerebral; this is the artery that is liable to become plugged by an embolus

BONES WITH NO MUSCULAR ATTACHMENTS

Ten; ethmoid, nasal inferior concha (turbinated), vomer, navicular (scaphoid), lunate (semi-lunar), cuneiform, Talus (astragalus), second (middle) cuneiform, incus

THE CLAVICLE COMMENCES TO OSSIFY BEFORE ANY OTHER BONE

LANDMARKS

A—LATERAL CEREBRAL FISSURE (FISSURE OF SYLVIUS)

Draw a line from a point one and one-fourth inches horiozntally behind the bregmatic (external angular) process of the frontal bone to a point three-fourths inch below the parietal eminence

B—BONY PROMINENCES AT THE ELBOW

I—The lateral (external) condyle of the humerus
II—The medial (internal) condyle of the humerus
III—Olecranon process of the ulna
If the forearm is extended the medial (internal) condyle of the humerus, the tip of the olecranon, and the lateral (external) condyle will all be found on the same transverse line. In extreme extension the tip of the olecranon is slightly above the level of the condyles. If the forearm is flexed to a right angle, the tip of the olecranon is immediately below the condyles

C—CENTRAL SULCUS (FISSURE OF ROLANDO)

Draw a straight line over the top of the scalp from the inion to the glabella; bisect this line, and at half an inch posterior to the midpoint draw a line downward and forward at an angle of 67.5° for a distance of three and one-half inches. This line will represent the location of the fissure of Rolando

D—UMBILICUS

Opposite the fibrocartilaginous disc, between the third and fourth lumbar vertebrae

E—END OF THE SPINAL CORD

Opposite the lower edge of the body of the first lumbar vertebra

F—INFERIOR ANGLES OF THE SCAPULAE

Opposite the spine of the seventh dorsal vertebra

G—CENTRAL TENDON OF THE DIAPHRAGM

Opposite the spine of the eighth dorsal vertebra

H—INFERIOR BORDER OF THE PLEURAE

Opposite the spine of the twelfth dorsal vertebra

I—APPENDIX VERMIFORMIS

The base is at a point two inches from anterior superior spine of the ilium, on a line drawn from this spine to the umbilicus

J—APEX OF HEART

At a point about an inch and a half below and three-quarters of an inch internal to the left nipple

K—APICES OF THE LUNGS

About an inch above the clavicle, behind the space between the two heads of the sterno mastoid muscle

L—KIDNEYS

The upper end of the left kidney would be defined by a line drawn horizontally outward from the spinous process of the eleventh dorsal vertebra and its lower end by a point two inches above the iliac crest. The right kidney would be half to three-quarters of an inch below these lines

M—TO TAP THE PLEURAL CAVITY

In the sixth or seventh intercostal space, midway between the axillary lines, or in the eighth intercostal space near the angle of the scapula

N—TO TAP THE PERITONEAL CAVITY

On the semilunar line or on the linea alba

O—TO TAP THE PERICARDIAL CAVITY

In the fifth left intercostal space, one inch from the sternum, or in the sixth left intercostal space immediately to the edge of the sternum

P—TO TAP THE SUBARACHNOID SPACE OF THE SPINAL CORD

In the middle line, between the fourth and fifth lumbar vertebrae

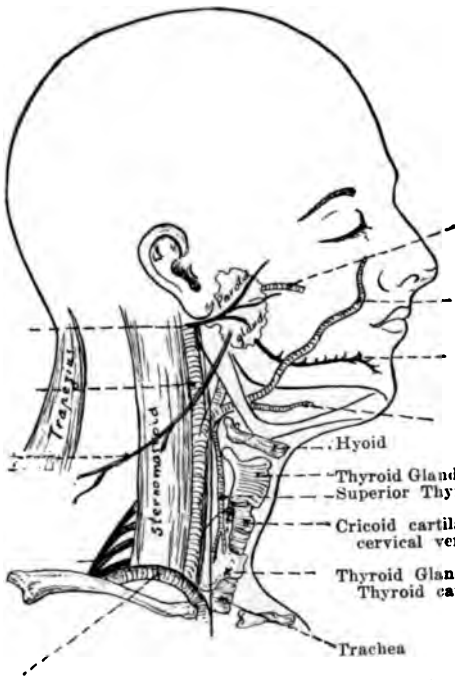

Parotid duct. (From lower margin of tragus to point midway between angle of jaw and tip of mastoid)
Facial Artery
Facial N. (Crosses ramus at level with lower border of lobule of ear)
Mt. Carotid A. (From sternoclavicular joint to midway between angle of jaw and tip of mastoid)
Mt. Dental N. (Midway between ant. and post. margin of the ramus)
Lingual Artery
Spinal accessory N. (From point between angle of jaw and mastoid to middle of post. border of sterno mastoid)
Brachial Plexus. (From point on post. border of sterno mastoid opposite cricoid to a point outside of middle of clavicle)
Hyoid
Thyroid Gland
Superior Thyroid Artery
Cricoid cartilage (Level of fifth cervical vert.)
Thyroid Gland (Before trachea from Thyroid cartilage down to clavicle)
Subclavian A. (Sternoclavicular joint to middle of clavicle)
Trachea

FIG. 232.—Topography of Face and Neck

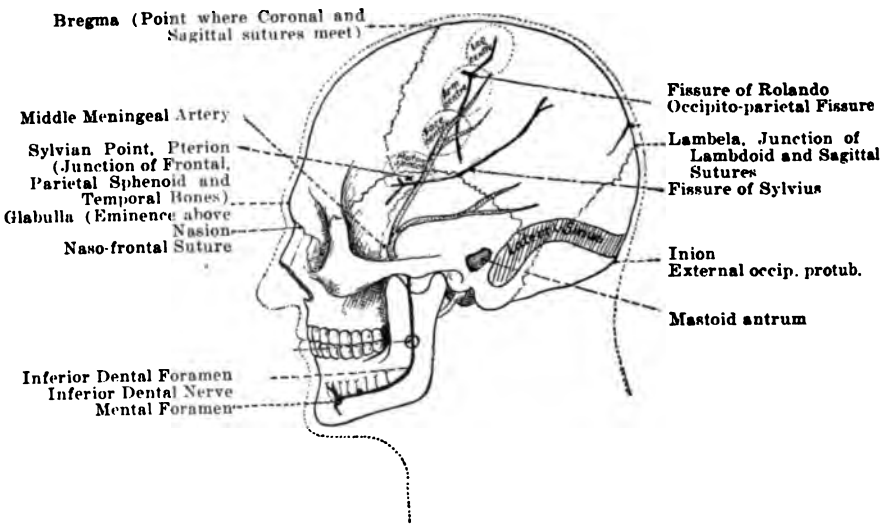


FIG. 233.—Topography of Lateral Sinuse

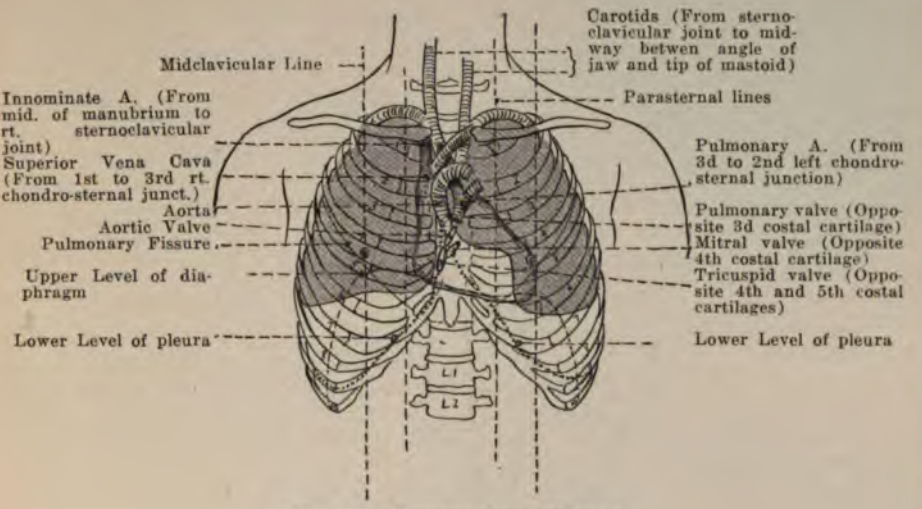

Carotids (From sterno-clavicular joint to mid-way betwen angle of jaw and tip of mastoid)
Midclavicular Line
Parasternal lines
Innominate A. (From mid. of manubrium to rt. sternoclavicular joint)
Superior Vena Cava (From 1st to 3rd rt. chondro-sternal junct.)
Pulmonary A. (From 3d to 2nd left chondro-sternal junction)
Aorta
Aortic Valve
Pulmonary Fissure
Pulmonary valve (Opposite 3d costal cartilage)
Mitral valve (Opposite 4th costal cartilage)
Upper Level of diaphragm
Tricuspid valve (Opposite 4th and 5th costal cartilages)
Lower Level of pleura
Lower Level of pleura
L1
L2

FIG. 234.—Topography of Thorax

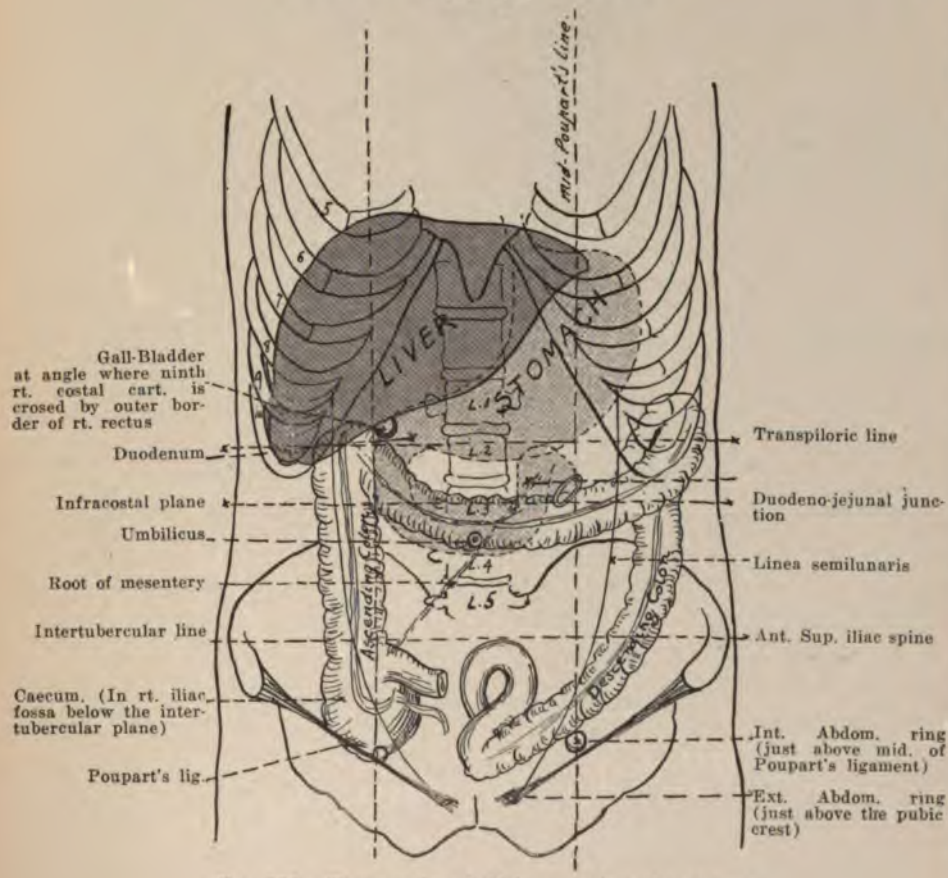


FIG. 236.—Topography of Abdomen (Anterior View)

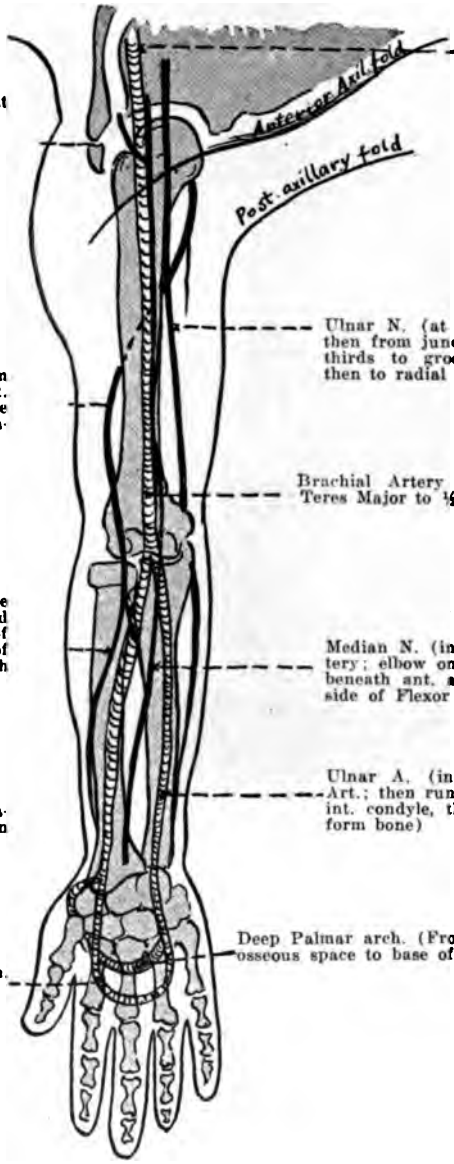

Axillary Artery (From outer border of 1st rib to lower border of Teres Major)
Acromio-clavicular joint
Anterior Axil. fold
Post. axillary fold
Ulnar N. (at 1st with brachial artery; then from junction of upper and middle thirds to groove behind int. condyle; then to radial side of the pisiform bone)
Musculo spiral N. (From junction of arm and post. axillary fold to groove betw. biceps and supinator longus)
Brachial Artery (From lower border of Teres Major to ½ in. below bend of elbow)
Radial N. (From groove betw. biceps tendon and supin. l., to junction of middle and lower 1/3 of the arm, then beneath supinate back to wrist)
Median N. (in arm same as brachial artery; elbow on its inner side runs down beneath ant. annular lig., then to ulnar side of Flexor carpi radialis)
Ulnar A. (in arm first with brachial Art.; then runs to the groove behind the int. condyle, then to radial side of pisiform bone)
Radial A. (From bifurcation of Brachial ends in deep ulnar arch)
Deep Palmar arch. (From upper end of 1st interosseous space to base of 5th metacarpal)
Superficial Palmar arch. (Continuation of ulnar)

FIG. 235.—Topography of Upper Extremity

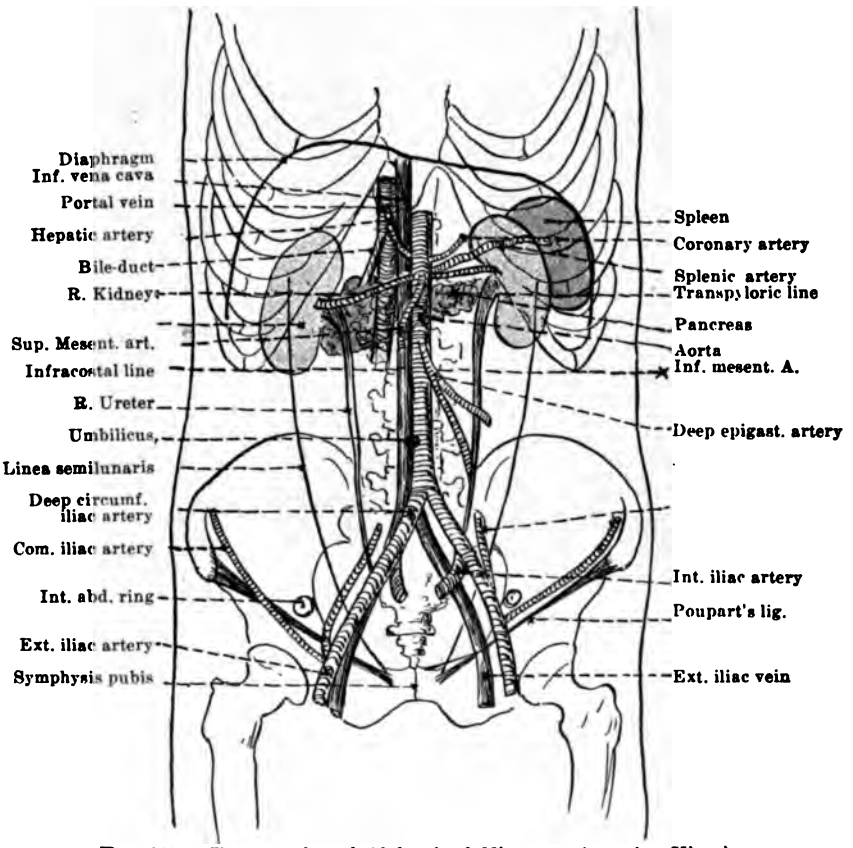


FIG. 237.—Topography of Abdominal Viscera (Anterior View)

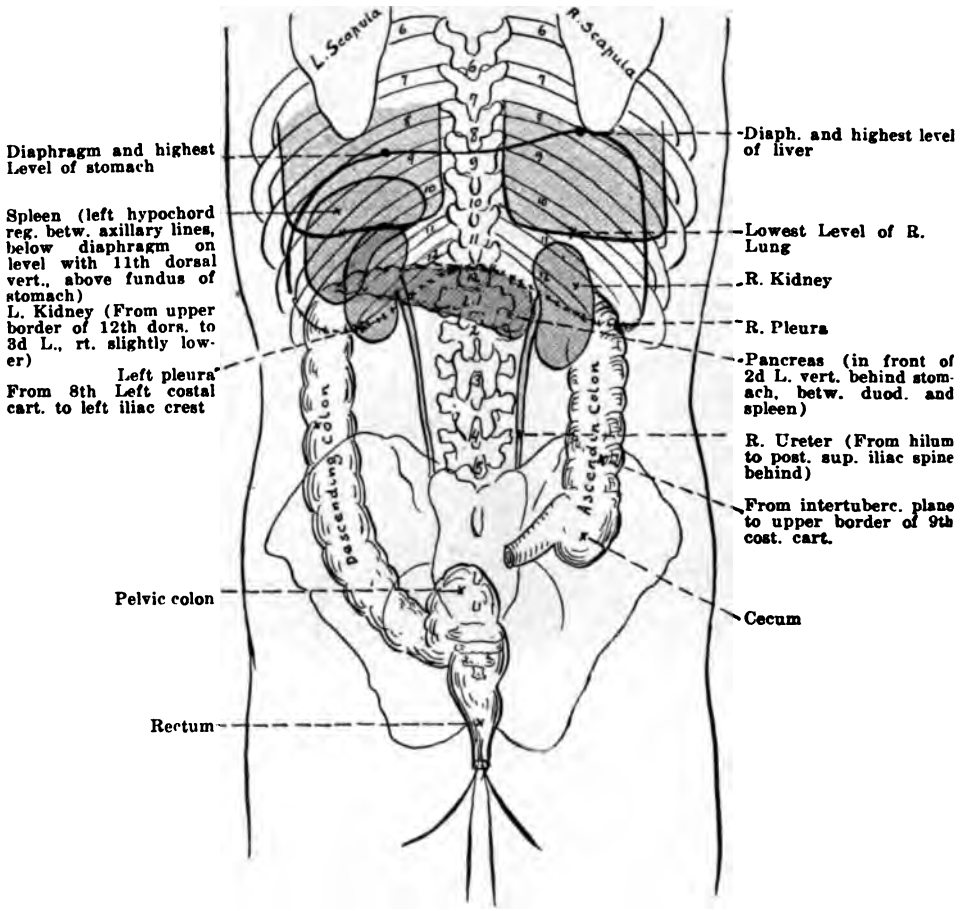

L. Scapula
R. Scapula
Diaphragm and highest Level of stomach
Spleen (left hypochord reg. betw. axillary lines, below diaphragm on level with 11th dorsal vert., above fundus of stomach)
L. Kidney (From upper border of 12th dors. to 3d L., rt. slightly lower)
Left pleura
From 8th Left costal cart. to left iliac crest
Pelvic colon
Rectum
Diaph. and highest level of liver
Lowest Level of R. Lung
R. Kidney
R. Pleura
Pancreas (in front of 2d L. vert. behind stomach, betw. duod. and spleen)
R. Ureter (From hilum to post. sup. iliac spine behind)
From intertuberc. plane to upper border of 9th cost. cart.
Cecum
Descending Colon
Ascending Colon

FIG. 238.—Topography of Abdomen (Posterior View)

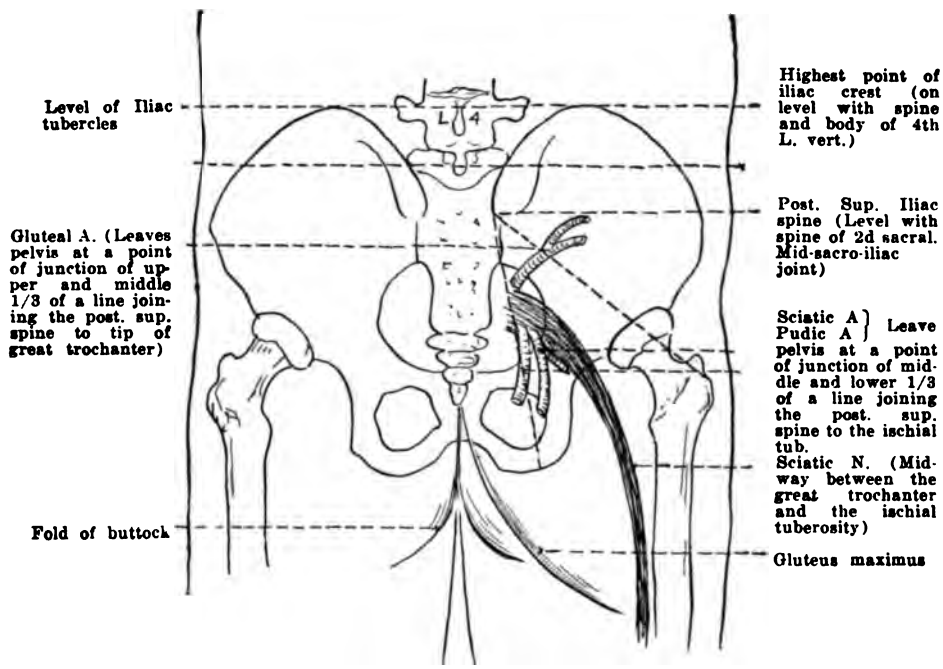

Level of Iliac tubercles
Gluteal A. (Leaves pelvis at a point of junction of upper and middle 1/3 of a line joining the post. sup. spine to tip of great trochanter)
Fold of buttock
L 4
Highest point of iliac crest (on level with spine and body of 4th L. vert.)
Post. Sup. Iliac spine (Level with spine of 2d sacral. Mid-sacro-iliac joint)
Sciatic A. } Leave
Pudic A. } pelvis at a point of junction of middle and lower 1/3 of a line joining the post. sup. spine to the ischial tub.
Sciatic N. (Midway between the great trochanter and the ischial tuberosity)
Gluteus maximus

FIG. 239.—Topography of Pelvis and Thigh (Post.)

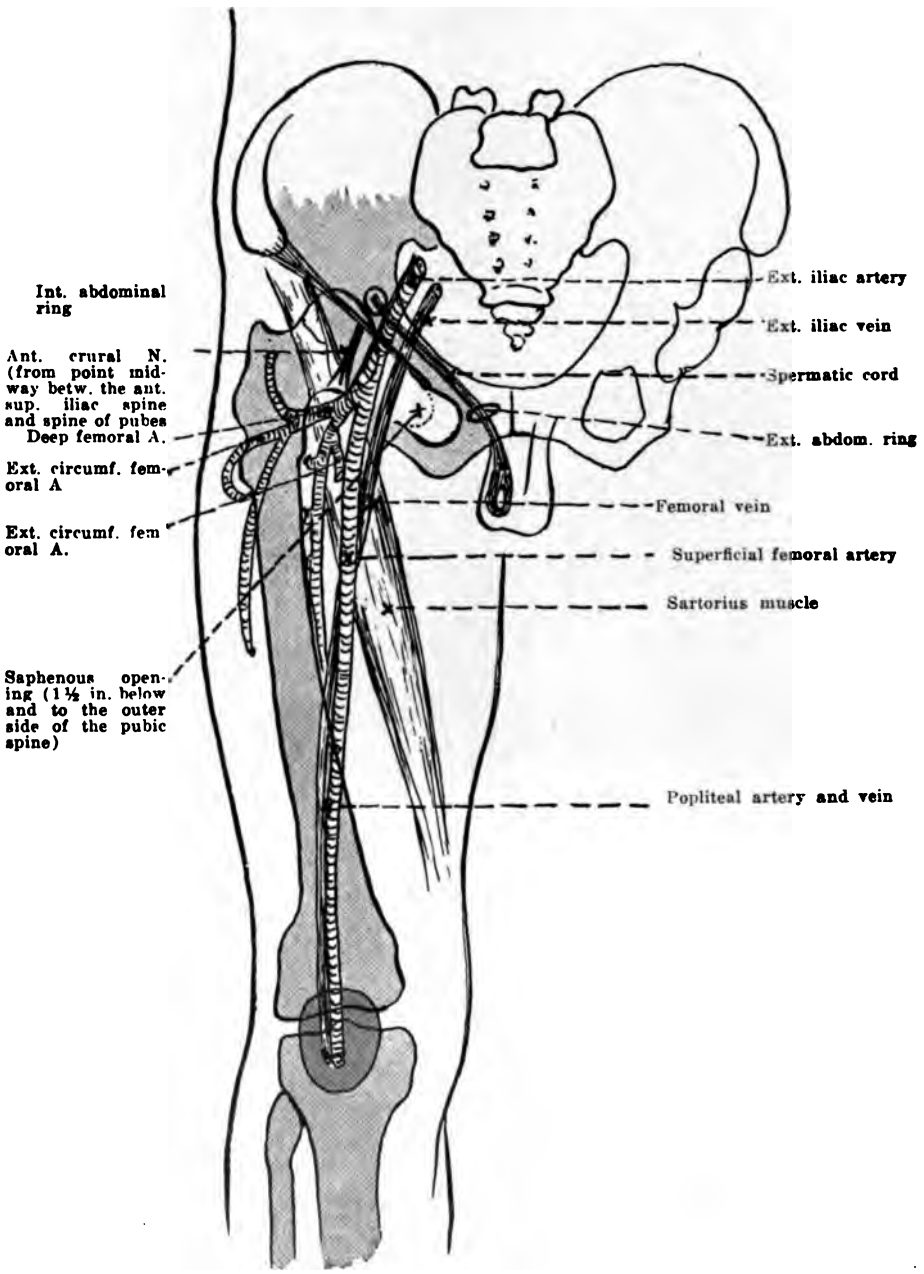

Int. abdominal ring
Ant. crural N. (from point midway betw. the ant. sup. iliac spine and spine of pubes
Deep femoral A.
Ext. circumf. femoral A
Ext. circumf. femoral A.
Saphenous opening (1½ in. below and to the outer side of the pubic spine)
Ext. iliac artery
Ext. iliac vein
Spermatic cord
Ext. abdom. ring
Femoral vein
Superficial femoral artery
Sartorius muscle
Popliteal artery and vein

FIG. 240.—Topography of Thigh (Anterior View)

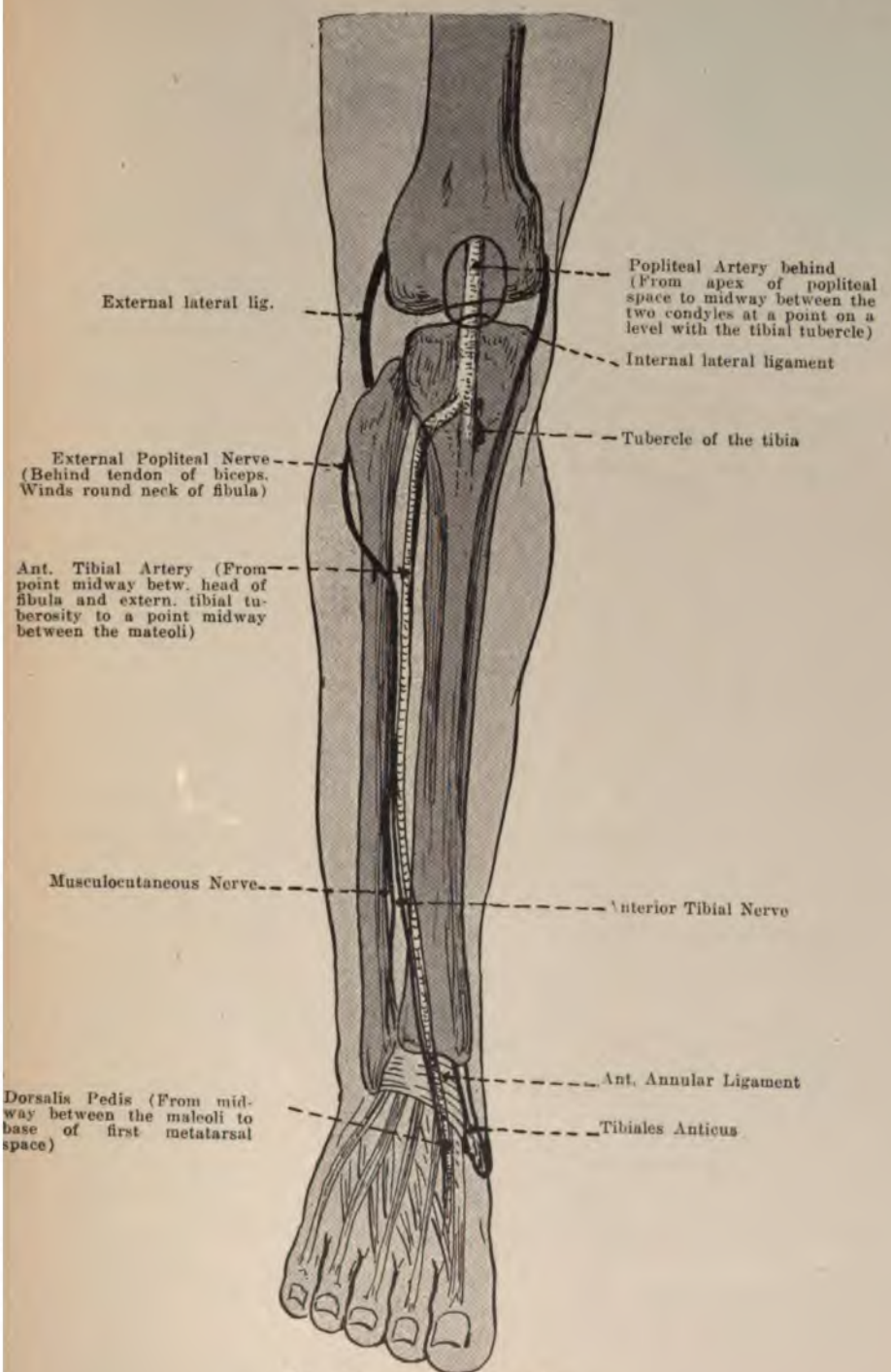

Popliteal Artery behind (From apex of popliteal space to midway between the two condyles at a point on a level with the tibial tubercle)
External lateral lig.
Internal lateral ligament
Tubercle of the tibia
External Popliteal Nerve (Behind tendon of biceps. Winds round neck of fibula)
Ant. Tibial Artery (From point midway betw. head of fibula and extern. tibial tuberosity to a point midway between the mateoli)
Musculocutaneous Nerve
Anterior Tibial Nerve
Ant. Annular Ligament
Dorsalis Pedis (From midway between the maleoli to base of first metatarsal space)
Tibiales Anticus

FIG. 241.—Topography of Leg

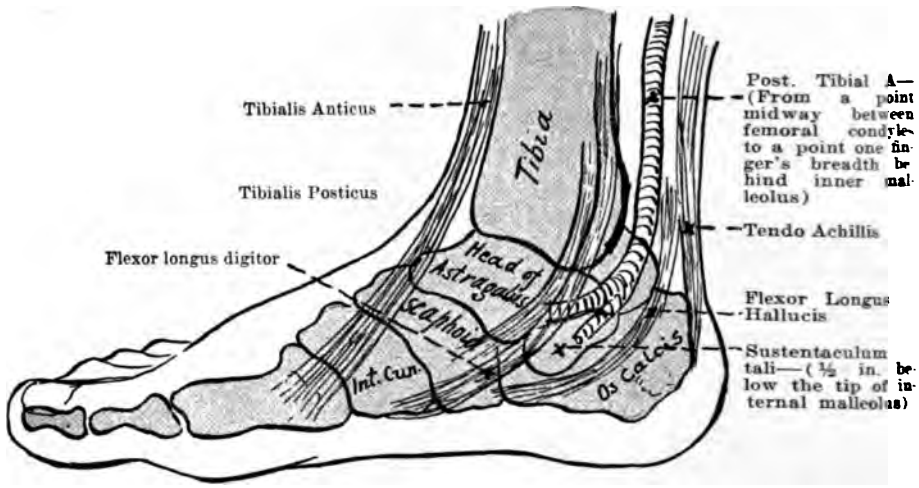

Tibialis Anticus
Tibialis Posticus
Flexor longus digitor
Tibia
Head of Astragalus
Scaphoid
Int. Cun.
Os Calcis
Post. Tibial A—(From a point midway between femoral condyles to a point one finger's breadth behind inner malleolus)
Tendo Achillis
Flexor Longus Hallucis
Sustentaculum tali—(½ in. below the tip of internal malleolus)

FIG. 242.—Topography of Foot (Inner Side)

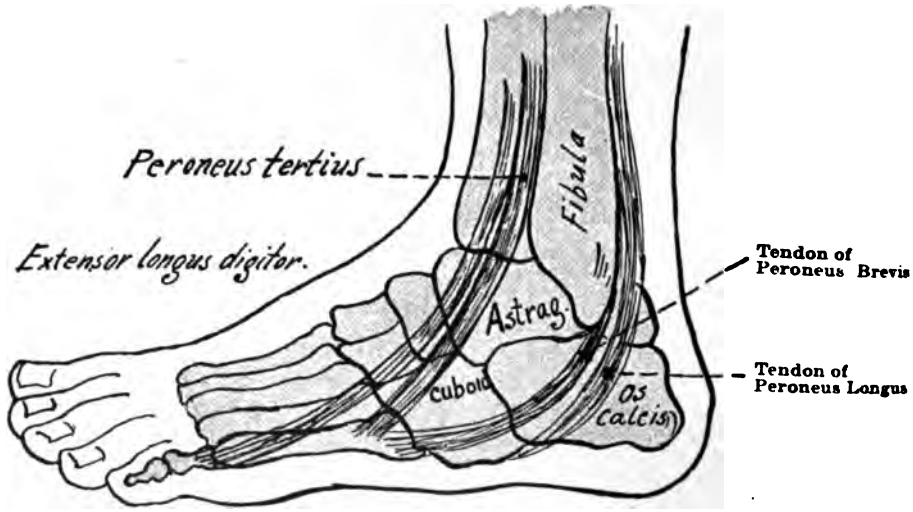


FIG. 243.—Topography of Foot (Outer Side)

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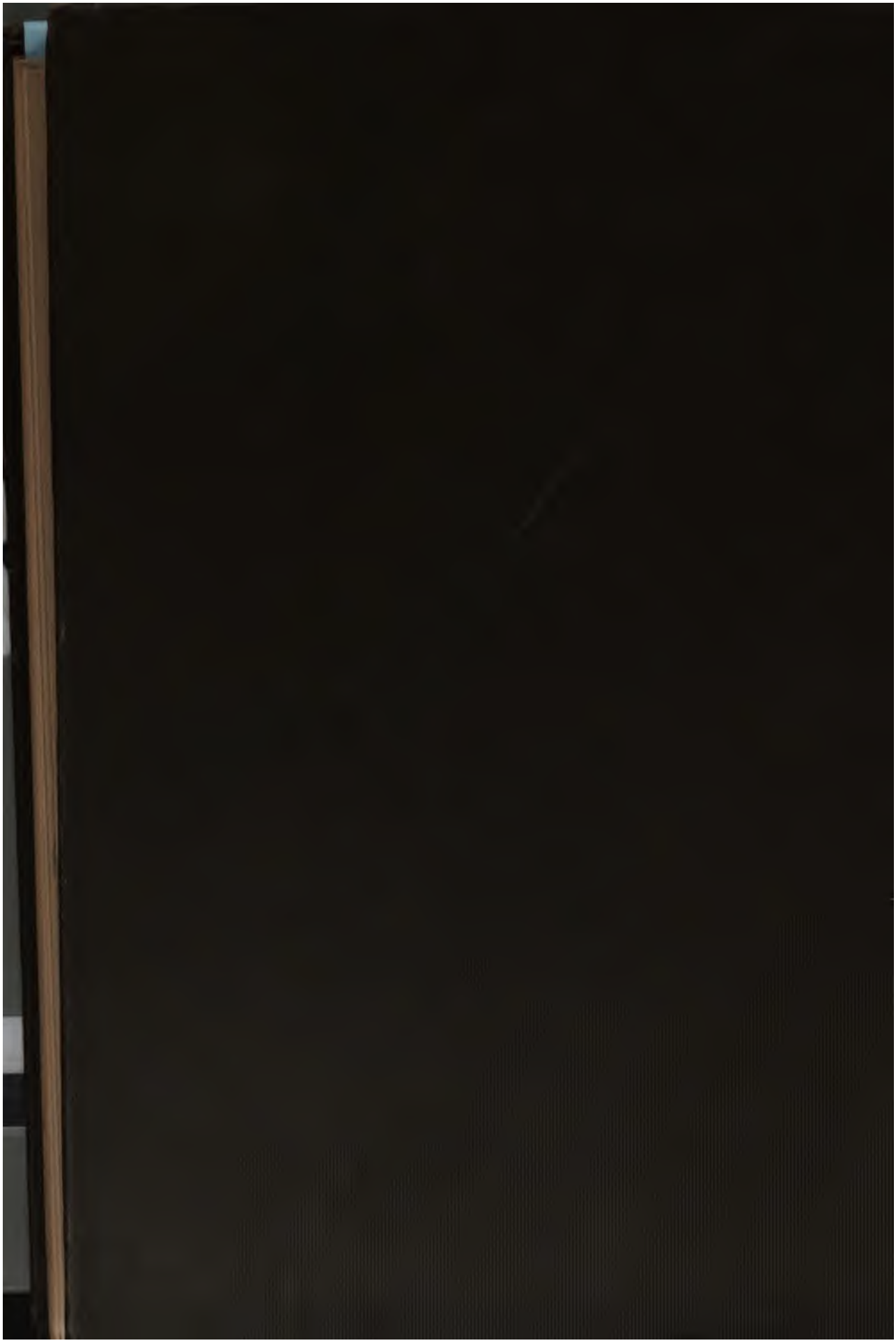
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